MODERN POULTRY FARMING

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MODERN POULTRY FARMING

By

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A Second Revised Edition of Practical Poultry Farming

PRINTED IN THE UNITED STATES OF AMERICA

TO

MY MOTHER,

LENA R. HURD,

WHOSE COURAGEOUS AND PROGRESSIVE SPIRIT

WAS AN INSPIRATION TO ME TO

UNDERTAKE THIS WORK

Preface

THIS book is prepared as a practical guide for both large and small poultry keepers and those interested in starting a poultry enterprise. The practices and methods are those most commonly used by successful poultry keepers and are based on scientific principles.

The author desires to express his appreciation to the following members of the Poultry Department at Cornell University, who read or approved parts of the manuscript in their particular field:

Mr. F. E. Andrews....... feeding, caponizing and general management.
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Dr. F. B. Hutt.......... genetics.
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Professor L. E. Weaver.... management.
Professor E. Y. Smith..... turkeys.

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The author wishes to express his appreciation for the assistance of Dr. E. L. Brunett, who read and approved the chapter on diseases and made several valuable suggestions. Dr. A. M. Goodman and F. L. Fairbanks of the Department of Agricultural Engineering of Cornell University for their suggestions on poultry house ventilation. Chapters V and XIII

are taken partly from Cornell Bulletins Nos. 153 and 410 written by these men.

Many of the pictures were especially taken by the author for this book. A number are from the files of the Poultry Department at Cornell University. In some cases illustrations have been taken from books or experiment station bulletins or have been supplied by commercial concerns, for which the author wishes to express his appreciation. Credit has been given in all such cases.

Although there is more information about poultry than ever before, it has not made the management of a flock any easier. If anything, it has added to the many conflicting ideas with regard to the best methods or practices to follow in caring for a flock. Every poultry keeper, therefore, needs to study, read extensively, and think clearly before starting an enterprise. Changes in practice should then be made cautiously and only when they are based on sound scientific evidence from reliable sources.

Ithaca, N. Y. L. M. Hurd

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MODERN POULTRY FARMING

I. The Business of Poultry-Keeping

POULTRY-KEEPING is interesting because it gives pleasure as well as profit to persons of both sexes, all ages, all walks in life in all sections of the country. It is useful alike on the farm and in the city back-yard, in the cold North, in the sunny South, in the hill and mountain country, or on the plain. It may be conducted as an exclusive business or as a side line. It affords pleasure and profit for rich and poor alike. In fact, it is the universal agricultural industry. United States census reports show that poultry is more generally kept on farms than any other kind of live-stock (Fig. 1). It is a health-giving recreation to thousands, as well as a means of support.

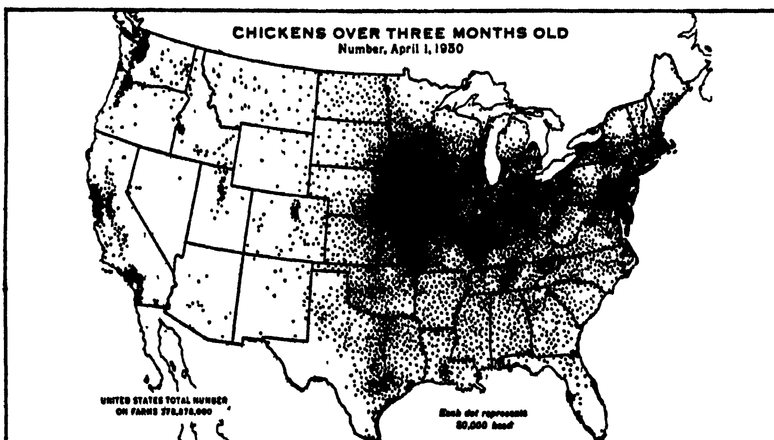


Fig. 1. The number of chickens on farms over three months of age in 1930. A large fraction of the poultry produced in the United States comes from the Middle West and Middle Atlantic States. U. S. D. A.

Few realize how large the poultry business is today, due to the fact that it is spread out over such a large area. The units, though small, count up quickly.

In 1941 the combined gross farm income from chickens and eggs in the United States was $1,172,466,000. The per capita consumption of chickens, dressed weight, in the United States in the same year was 20.3 pounds; eggs, 345.

DEVELOPMENT OF THE INDUSTRY (Figs. 2, 3, 4)

As an occupation, poultry-keeping is comparatively new, although poultry has been raised for domestic purposes or

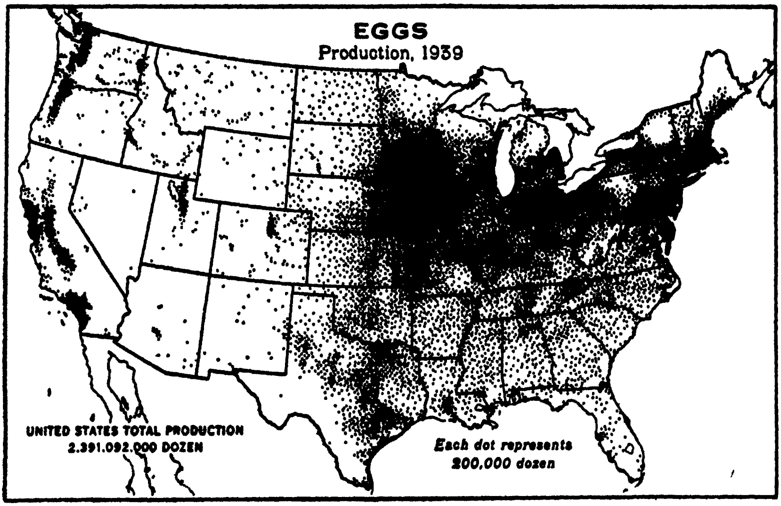


Fig. 2. Eggs produced on farms in 1939. About half of the eggs produced in the United States come from a few states in the Middle West. U. S. D. A.

otherwise for over thirty centuries. No attempt was made to keep poultry in any extensive commercial way until within the last half century. Fifty and sixty years ago there was very little scientific or general information in regard to poultry-keeping. Practically no farms kept as many as 1,000 fowls, or even 500. Few if any tests were made at experimental stations, and even farm papers had given little attention to this occupation, while colleges had not taught it in any form.

Today, however, practically every state college is teaching the science of poultry husbandry and many are doing ex-

tensive experimental work also. There are hundreds of young men and women graduating from these institutions with special training along this line. Thousands of others in all parts of the country have become expert through long years of experience. It is not uncommon now for poultry-farms to keep 5,000 or more hens. The business of raising chickens is no longer merely a source of pin money for the farmer's wife, but rather, an interesting occupation giving employment to thousands.

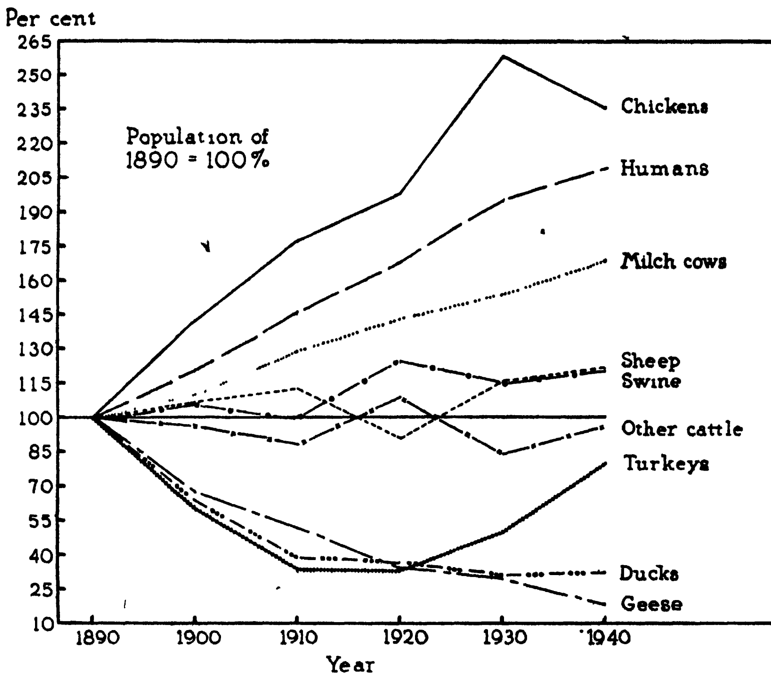


Fig. 3. Trends in numbers of principal farm animals from 1890 to 1940. U. S. D. A. Statistics 1941.

One result of the rapid development of the poultry industry has been the broadening of the field of specialization within it. This has been stimulated by the rapid increase in the amount of poultry kept and the newer methods of caring for it.

Only a comparatively short time ago all hatching and rearing was done by the natural way. This did not encourage rapid development, because it was slow, tedious and expensive. To-day, through the ingenuity of man, incubators have been constructed, which hold thousands of eggs and are operated mechanically so that man scarcely has to touch his hand to the eggs from the time they are placed in the incubators, until hatched. These machines hatch the eggs just about as efficiently as does the old hen, and sometimes more so. Various types of heating devices have been perfected which permit little chicks to be brooded in groups of 50 to 1,500 at a time, thus eliminating the cumbersome natural method and considerable labor. These recent changes call for more skill

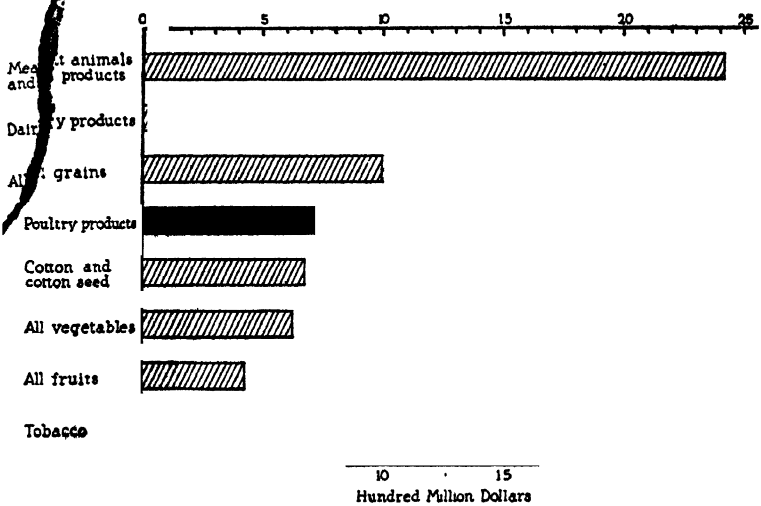


Fig. 4. Estimated cash farm income of principal farm products in 1940. U. S. D. A. Statistics 1941.

on the part of the operator and at the same time make the business more interesting. The poultryman no longer needs to confine himself to the production of eggs and meat only, but can hatch chicks, grow pullets and do many other things

for those less experienced. Those with limited capital, facilities, or other reasons are more and more depending on the expert poultryman for their chicks. Many prefer to buy their quota of young stock each year rather than raise their own. All this development opens new avenues of effort for poultry-keepers and promises well.

As food poultry products rank with the highest and grow in popularity each year. New York City alone in 1942 received 174,456,600 dozens of eggs; 119,559,040 pounds of live poultry and 253,091,193 pounds of dressed poultry.

As the population and wealth of the country increases, there will be more demand for high-quality products in quantity and this in turn will offer greater opportunities to those who wish to specialize. Already many poultry-keepers near large cities are selling their products at their doors for fancy prices and the demand for the best is increasing. The slogan of the future is quality.

CAPITAL REQUIRED

Poultry-keeping can be started in a small way with little capital. Anyone having the space and a few old buildings can begin. In fact, some of the most successful poultry-farms in the country today have started in this way.

Poultry products are usually sold for cash. There is no waiting for returns over long periods with the uncertainty of weather conditions and danger of over-production, as is the case with most farm crops. Poultry is not seriously affected by drought or rain. The spring surplus is stored for use during the winter period of low production. As a matter of fact, the use of cold storages for poultry products in recent years has helped greatly to stabilize prices. On a well-managed poultry-farm there is a steady income the year round, thus allowing the farmer to pay his bills promptly and keep his credit good. In fact, the whole family is benefited by it. Quick returns mean

a more frequent turn-over of capital and an opportunity to save by paying cash. Lastly, poultry products are more easily and cheaply marketed because of their concentrated form.

PERSONAL QUALIFICATIONS

The success of any enterprise depends quite largely on the person in charge. Not everyone will succeed with poultry any more than they will in any other business. Certain personal qualifications are needed. The most important are: a natural liking for poultry; willingness and ability to work; business ability; good judgment and character. It is well to keep in mind that poultry-keeping is a business dealing with a large number of small things which require close observation to prevent losses. This demands patience and fondness of detail. Orderliness and cleanliness have their place also for without them a poultry-farm soon becomes untidy and unsanitary. A poultryman can never allow himself to become careless for just as sure as he relaxes his vigilance, losses soon occur. Many start this business and do well for a time because everything is new to them and they put much hard work and thought into it, but later they lose interest or become indifferent to the fundamental requirements. When this happens and they fail, their lack of success is attributed to their occupation. The business is not at fault but the individual, who is unwilling to be responsible for the details. Some persons believe that it takes little effort or thought to succeed with poultry, and that it can be picked up or dropped with profit on short notice. This idea has been responsible for many failures, for to succeed in this undertaking, as in any other business, it requires hard work, brains and ability.

OLD AND NEW TYPES OF POULTRY

In the recent development of the poultry industry, there has been a growing inclination to emphasize its practical side. In the early days those most interested kept poultry for the pleas-

ure they derived from breeding birds of a certain color of feathers and type of body. Their efforts were directed mainly toward beauty and not so much toward production or meat qualities. It was fortunate that this was so, because out of it have come the fine modern standard breeds and varieties of fowls. The industry owes much to those pioneer breeders, but their work is not completed. It remains with the present generation to build better strains of stock on this old and solid foundation. The breeders of forty and fifty years ago had little except observation and experience to guide them and they used it to advantage. Poultry-keeping did not have the importance then that it has today. The modern development of the industry, with the increased number of birds kept and specialization, has forced those interested in a large way to consider the production of their birds in order that they might make the business pay. The bulk of the returns on a good-sized poultry farm usually comes from the sale of eggs and meat. Therefore, at present and in the future, the great problem of the breeder will be to take breeds and varieties of poultry which have been standardized and perfected as to appearance by the older fancy breeders, and add to it the valuable quality of high production.

II. Starting a Poultry Enterprise

IT IS generally conceded that the best way to start a poultry enterprise is to begin modestly and let the business build its increases (Fig. 5). In fact, in almost any type of farming, real success usually comes in this way. This plan is both economical and safe for those with capital, as well as those without it, and allows the owner to accumulate experience and business ability as the farm develops. The experienced person or the beginner can well afford to proceed carefully with an earnest determination to study the fundamentals thoroughly, and put them into practice with discretion. Mistakes undoubtedly will be made, for no business or undertaking is without them, no matter how well planned. However, the greatest errors come when there is no organization or definite plan of action and those in authority take too many chances. The novice, then, is confronted with the problem of deciding how the business will be developed.

The best method of procedure is to take stock of all resources and outline a definite plan of action. If limited as to capital, it may be possible to keep poultry as a side line while working at some other occupation. When the business develops to such a point that the owner feels justified in giving it all his time, the other work may be dropped. Another way is to work for a time with some good poultryman. Both of these plans are good, for they provide a means of livelihood while gaining experience, as well as an opportunity to save money. The latter plan has the most in its favor, because there is a chance not only to do the practical things, but to observe how the owner conducts a successful business. Experience is a good teacher, but too often an expensive one. For this reason the inexperienced person is unwise, unless money-making is no object and poultry is kept as

WAB SALAR JUNG BAHADUR

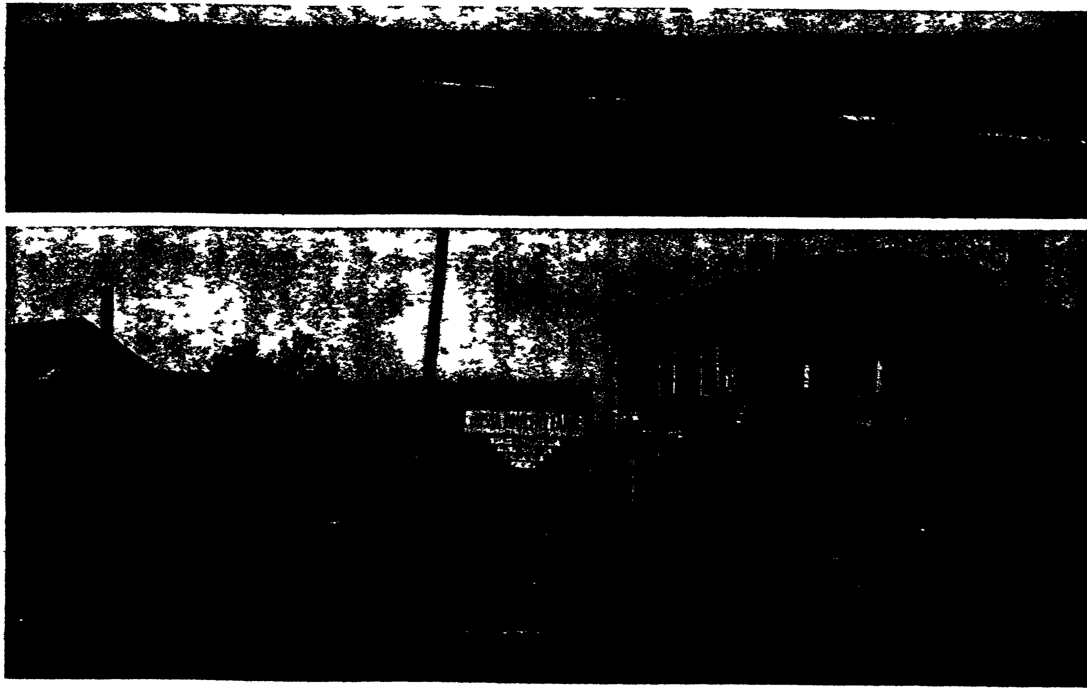


Fig. 5. A modern poultry farm and home.

a pastime, to buy a farm and depend on earning a living from it, while learning the business.

Of late years, there have been many opportunities for persons with practical experience, but little or no capital, to form a partnership with those having the necessary cash and a desire to build up a poultry plant. To arouse the interest of well-qualified persons many attractive inducements are offered, because the owner feels that under the circumstances the business will be better conducted if both parties share alike in the profits and responsibilities. For the same reason, the proprietor of a good business of long standing, due to labor difficulties, old age, or poor health, many times is anxious to find some one to continue the business, who he feels, by having a larger personal interest than the salary he receives, will give it greater consideration. Partnerships of this type in poultry-keeping seldom endure, for many difficulties arise. The man with money, not understanding the business and perhaps expecting too much from it, becomes dissatisfied and disinterested. The practical man, not having any of his own money at stake, may be too free and careless in spending his partner's money, and besides lack the ability to conduct the business properly. The personal make-up of the two may not be such that they can get along well together. Also, the business may not be large enough to allow two families to receive a reasonable income, when it is divided. It may be possible under certain very favorable conditions to have a successful partnership, that will last and be profitable to all parties concerned, but the writer knows few such instances during the last ten or fifteen years.

The renting of a farm offers possibilities to those with limited capital. Here again there are serious objections, for the business that one man will probably have at the start is not likely to be large enough to furnish sufficient profits to warrant sharing them with the owner. Besides, all buildings or permanent improvements made by the tenant belong to the owner. This and the fact of not owning the place are handicaps, because

there is no desire to invest in the necessary equipment. Perhaps there is some justification in renting a place for a year or two with the option of buying later, for, in this way, a good idea of the possibilities of the farm may be obtained.

Anyone interested in poultry-keeping today can obtain valuable information and instruction at most all the state colleges of agriculture. Nearly all these state institutions, in addition to the numerous free bulletins and leaflets on methods and results of experiments, provide a special extension service to aid the people of their respective states in securing the best possible results by following the most approved methods. Besides this, there are many books and farm papers with timely advice. In fact, there is so much information of so varied a character that it is puzzling for the inexperienced person to know just which is the best course to follow. It is best to select an approved method and be very conservative about making changes.

LOCATING THE BUSINESS

The regular poultryman's year usually begins in the fall, when the young stock is housed and the place put in shape for the winter. However, when one is starting a new poultry business, it is better to begin in the spring or early summer. This allows the owner to grow his own pullets, build any necessary buildings, raise green food and organize the plant before cold weather comes.

Size of farm. The size of the farm depends on the number of birds to be kept, the amount of capital available for investment, the value of the land, and whether the farm is to be devoted wholly to poultry-keeping. It has been demonstrated, when proper sanitary methods are followed, that poultry can be kept in quite close quarters without showing any serious injury either to the egg production or vitality. For this reason, the poultry-keeper can get along with less land than most types of farming require and also have less money invested. A farm

of 5 to 25 acres in a good location is sufficient. Although no definite rule has been established, through experiments, for determining the proper amount of land needed for a certain number of hens, the ideal space usually allowed is about 1 acre to each 100 fowls. This provides room to follow a system of rotation in growing the chicks as well as range for the old stock and ground on which to grow the green food. It is well to consider the possible growth and expansion of the business, for often adjoining land cannot be acquired. Of course the place may be sold and a larger one purchased, but few like to do this after building up an enterprise.

Judgment must be exercised to keep the investment in land at a low enough point so that the poultryman can realize on his labor. Usually, it is not advisable to pay more than $150 to $200 an acre, unless the buyer has considerable experience and expects to conduct a business in proportion to the money invested. The nearer the place can be located to a large city and good markets and still have the investment within reason, the better.

Climate. Poultry will do best in a moderately cool climate, with uniform temperatures and a maximum amount of sunshine, although it will adapt itself to most any condition. Areas subject to sudden periods of high or low temperatures, such as the middle part of the United States, are not as good as those sections nearer the coast. All poultry, except water fowl, are affected by strong winds and excessive moisture. A foggy moist atmosphere, especially during the winter season, may cause damp litter and much discomfort. Thus, it is well to select a situation in a hilly section with a reasonably dry atmosphere, protected from the sweep of the winds by timber land or the irregularity of the country, and not too close to the coast line or any large body of water to be troubled with fogs.

Soil and drainage. The best soil for poultry-keeping is a rich sandy loam, because it is easily drained, warms up and dries out quickly. A sandy soil, moreover, is more easily kept clean,

for it is loose and porous so that the filth from the poultry droppings can wash away. Heavy soil, like clay, is more compact and sticky and holds moisture longer, consequently it is cold and more likely to be unsanitary. A farm which is not capable of producing good crops under favorable conditions is just as poor an investment for poultry-keeping and should be avoided. Rough stony ground or timber land make a poor location for poultry, because it is hard to prepare the land for improvements and more difficult to keep the soil in a sanitary condition. Very hilly land, likewise, is hard to manage. The ideal poultry-farm should consist of good easily tilled land sloping gently toward the south so that it has natural drainage as well as sunshine.

Location of the farm. The success of a poultry enterprise depends to a large extent on its location. Many factors enter into its choice, and those with experience differ as to whether the farm should be located near good markets at greater expense, or some distance away where good land and equipment can be obtained more cheaply. There are arguments on both sides, but it must be remembered that it is of prime importance to keep the investment as low as possible to have a practical plant. A small investment in land gives the owner with limited capital a better chance to get started in an efficient manner. If the property is situated in the open country, experienced farm labor can be secured for less money than near the cities, where it is influenced by factory conditions and city prices. Also, quite often at harvest time such grain as corn, wheat, barley and oats can be bought more cheaply delivered at the door by neighboring farmers, than at the feed store in town.

There is less danger of stealing in the country districts than near the city, where it is handy and easy for pedestrians, as well as those in automobiles, to take poultry and dispose of it quickly.

The greater the distance from any large city, the more important it is to be near a trunk line of railway, and on an im-

proved highway so that there is a rapid and reliable means of communication with good markets. Likewise, it will be much easier and cheaper to secure the proper feed and supplies.

The more distant the producer is from the place where his products are sold, the more dependent he is on good mail, telephone and telegraph service. Now that artificial lighting has come into such general use and is so necessary for the successful management of a flock of hens, it is important to be so located that power can be obtained easily.

Good roads are more important than ever because of the increasing use of automobiles for transportation purposes. When the farm is easily reached, many city people will drive considerable distances to buy direct from the farmer and, if properly located, it is possible to sell poultry products wholesale as well as retail at the door for good prices, thus saving time and expense of transportation (Fig. 6). Egg dealers and market men today are more anxious than ever to secure high-quality products and often will go after them, when the farm is not too far away. A farm located on a well-traveled and improved highway receives much public attention and seldom decreases in value. The careful buyer will try to combine, as best he can, all the advantages of the distant location with those of a place situated as near the city as he can afford to purchase.

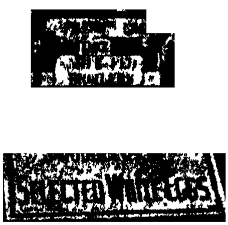


Fig. 6. A typical road-side sign.

Many lose sight of the social side in their endeavor to get started in a good location. Agreeable and accommodating neighbors, good schools, active churches and a community that is generally alive and thrifty, play an important part in the success of a farm, as it keeps the whole family in a satisfied and contented frame of mind. Furthermore, a farm in an enter-

prising community is more likely to increase in value because of its surroundings.

FINANCING THE FARM

One of the big problems which confronts many beginners in poultry-keeping is the question of financing a farm. How much money is needed? What constitutes a safe and sound investment? These are difficult questions to answer for much depends on the size of the business, the type of specialization, the experience and ability of the owner. Of course if the enterprise is small and a side line in connection with some other occupation, the investment in land and equipment is small and there is no serious financial problem, but when the enterprise is large enough to take a good part or all the time of the owner and is the principal source of income, it means considerable financial outlay. Under these conditions it is necessary to have a farm, and here the problem begins. There are many different ways of purchasing a farm, but the most common methods in use are as follows: (1) Purchase entirely for cash; (2) one-half or one-third paid in cash and the balance remaining on first mortgage; (3) one-fourth paid in cash, one-half on first mortgage and one-fourth on second mortgage; (4) one-half or one-third paid in cash and the remaining on first mortgage to be paid in regular installments; (5) personal credit from friends or others.

When cash is paid for a farm, the problem is simplified. Too often, however, the buyer makes a serious mistake in putting all or too much of the available cash into land and buildings at the start without making the proper deductions for stock, equipment and maintenance until the business is on a paying basis. On the other hand, it is not good policy to start a plant on too much credit, even if it is possible to get it, for unless the business proves to be very good, there may not be profits enough to provide for a decent living for the family, pay the necessary interest, taxes and insurance, and have anything left

to pay on the principal. Furthermore, under such conditions much depends on the health of the family, for accident or lingering illness on the part of the proprietor or members of the family may require so much extra money that it will be impossible to meet all required obligations. For this reason, it is usually considered unwise for more than two-thirds of the value of the property to be borrowed and it is much better if 50 per cent is paid down at the time of purchase. It is never safe, neither is it good judgment, to assume any obligation, and especially a large one, without being reasonably sure of a way of paying it off at the proper time. One should never take unnecessary chances, for there is enough speculation in the ordinary routine of conducting a farm. Instead of rushing into the business with insufficient funds to develop it or assume an impossible load of credit, it is much better to wait until some cash has been accumulated before making the start. In any case, it is wise to plan conservatively and make greater allowance for expenditures than anticipated. The proper use of credit is desirable and advisable, but it must be used with discretion.

Many places loan money on farm property. The most common are savings banks, federal land banks, and private lenders.

In making any application for a loan, whether from a bank or individual, it pays to be perfectly frank and truthful. All banks have experienced appraisers who look property over upon which money is to be loaned. If the valuation is much too high, or the statements in regard to it are exaggerated, a feeling of distrust follows which may result in a refusal of the loan altogether. It is a good plan when approaching the representative of a bank or any private individual for credit, to prepare a written statement showing in detail all assets in cash, real estate, stock, bonds, as well as all liabilities, such as mortgages, notes, bills. This immediately gives the financier a view of the financial status in terms he understands. Officials of many country banks are familiar with the agricultural possibilities

of the surrounding country, know the value of most of the farms near by and the character of the men who run them. A person's reputation in such a community will often go a long way in securing credit. Probably there never was a time when it is so easy to get personal credit as now, if the individual shows that he has character, a willingness to work and ability to save money.

When asking for credit on a farm business, the most important factor is not so much the rate of interest as it is the permanence of the loan. It must be so arranged that the mortgages or notes will not be called suddenly and unexpectedly and thereby cause embarrassment, expense and perhaps even the loss of the property. The type of a poultry enterprise is such that long-time credit is most imperative and decidedly the safest policy. It is always easier to sécure credit on good land well located because it holds its value much better.

ORGANIZING THE BUSINESS

Poultry-keeping is most common as a side line to general farming. In some parts of the United States it is often combined with fruit-growing, dairying and vegetable-growing. In this case, poultry may or may not be the main issue on the farm. Many such combinations are very successful, when the operation of the one type of farming does not interfere too much with the other, and the owner has extensive and broad experience in farming. It would be unwise for anyone without farm experience to attempt too much at the start. The old saying, "It is better to put all your eggs in one basket and watch that basket," would certainly apply in this case. On a combination farm it takes good business ability to prevent mismanagement of one sort or another. On the other hand, much can be said for the diversified farm, if the diversification is not carried too far. If one branch of the farm fails, due to overproduction, poor management, or otherwise, some of the others are sure to turn out well. Besides, there is the opportunity for

efficient use of land, labor and equipment. The same is true of poultry-keeping as a business. The best type of poultry-farming is not the one which confines itself to the specialization of one phase of the occupation, such as the production of market eggs, meat, breeding stock, but instead is a combination of them all.

A plan of the farm. It is difficult in choosing a farm, or adapting one for poultry, to have all the points, such as the soil, topography, shape, just as they should be. Ideal farms combining all the necessary qualifications are few and, therefore, it is best to make the most of a fairly good location. Having secured a farm, before any moves are made, the possibilities of the place should be studied. The lay of the land, the situation of old and new buildings (Fig. 7) and their accessibility, the water supply, the source of power for lights and the arrangement of fields for yards and ranges, are to be taken into consideration.

Fig. 7. A barn remodeled into a poultry house. This is an inexpensive way to get started in the poultry business. Such buildings, when properly fixed over, make excellent quarters for hens.

It is desirable to sketch a plan of the farm and on it, using the dwelling-house as a base and keeping in mind the lay of the land, indicate the position of all buildings, roads, fences and ranges, measure off the distance between buildings and try in every manner to centralize the plant to save travel and labor without in any way interfering with the proper management of the stock. All buildings should be faced toward the south and, if possible, located on land sloping gently in the same direction, but far enough below the crest of the rise to be protected from winds. If woodland or orchards are on the windward side, so much the better. The air in such a location is

more likely to be active, thus assuring good air drainage. Hollows and lowlands are to be avoided, not only because of poor land drainage, but the tendency for a cooler damper atmosphere in winter. Yards are not being used in connection with laying houses or permanent brooder houses in many parts of the country; but where they are desired, they should be made large enough both in front and rear of each laying house and permanent brooder-house so that the land can be worked easily, if necessary. A double yard system is an advantage, because crops can be grown in the runs, thus preventing weeds and refuse from collecting and the soil from becoming unsanitary. During the colder months of the year the hens will enjoy the heat and protection of the front yard, while in the summer the yard at the rear in the shadow of the building will be cooler and more comfortable. In sections of California where the climate is very hot and dry during the summer months, the laying houses are often built facing the east, so that more ground is shaded during the heat of the afternoon. In general, the more desirable type of farms are nearly square in shape, with hills or woodland so located that there is an unobstructed view of the property from the residence.

The water supply. The water supply on a farm is one of the most important points for consideration and a never-failing well or spring is a necessity. A good spring located high enough so that the water will run by gravity to all parts of the plant is a very valuable asset, because no power is needed for its operation. If the source of water supply is a well or a spring below the level of the plant, the water can be raised to a tank by means of a hydraulic ram, gasoline engine, electric motor or windmill and then to all parts of the place by gravity. In recent years, the use of compression storage tanks operated by an automatic electric motor or gasoline engine is a very popular and an efficient way of providing running water for a plant. In a cold climate where there is danger of freezing, it is necessary to protect all parts of the equipment carefully. It is best

to locate the pump and storage tank in some well-constructed building. The basement of the residence is a good place because it is well protected and close at hand. The pipes leading to all parts of the plant should be buried below the freezing point. Outlets in the buildings should have a cut-off or drain-pipe deep in the ground which will draw off the water in exposed sections of pipe and thus prevent them from being damaged. It is extravagant to allow water to run freely in poultry-houses, even where there is no danger of freezing, unless the supply is obtained cheaply from a good spring. A constant supply of fresh water can be provided economically with any system by using an automatic valve. This valve is attached to the water container in such a way that, as the water is removed from the receptacle, the variation in weight slowly opens the valve and allows the water to run until the container is filled to the original point. A good water system on a poultry-farm saves more time and labor than any other equipment and, therefore, adds greatly to efficiency of the business.

Buildings on a poultry-farm. In addition to the residence, the following buildings and facilities are needed on a well-equipped poultry-farm: (1) Suitable laying houses and equipment for the mature stock desired; (2) brooder-houses and equipment for raising the proper number of chickens; (3) a barn to be used for storage of hay, straw, feed, egg-cases, truck, farm tools, quarters for fattening poultry and stables for horses and cows, if desired; (4) an incubator cellar; (5) egg room; (6) shipping room, to be used for killing and dressing poultry, candling and packing eggs, carpenter's bench and tools, oat sprouters, and a general headquarters; (7) feed-room, with floor large enough to mix feed in ton lots; (8) shed for storage of manure; (9) fireplace to burn carcasses of dead birds.

The laying house should be located as near the residence as is practical. If this house is very long, the usual plan is to construct the storage and general headquarters building in the

center with the feed-mixing room, the shipping room and office on the first floor. The incubator cellar and egg room may be located under the same building and the manure shed can be placed on one end of the laying house. The buildings and ranges for the young stock should be as close to the main poultry building as conditions will permit. Every effort should be made in the arrangement of the place to save time, labor and travel.

III. Choosing a Breed

POULTRY-KEEPERS wish to know which is the most profitable breed. Perhaps no question pertaining to the business is so hard to answer definitely, because the choice depends on so many different factors. One of the most important is that of breeding. With this in mind the beginner can safely set down as the first practical rule in the selection of a breed, that it must be pure-bred and of a good strain. Pure-bred stock has the advantage of having been selected for generation after generation for uniformity of type, color or production. Such stock is more likely to produce offspring with the desired qualities, than mongrels whose breeding has been varied and uncertain. Many experienced breeders claim that the crossing of breeds not only increases the vigor of the offspring but stimulates the egg production and improves the quality of the meat. This may be true, but the same results can be accomplished in a much more satisfactory and profitable way by selecting one breed and giving it careful attention. There is no sound experimental evidence which shows that the keeping of mongrels is any real advantage.

The second step in the selection of a breed concerns the type of business to be conducted. Those desiring to specialize in table fowls should study all the breeds usually considered for this purpose and make a choice according to their fancy. Those interested in the production of eggs will turn to those breeds best adapted for that purpose.

Markets have much influence on the type of breed kept. Usually the most money is made and the highest prices are received by catering to their whims. It is obvious that a breed producing brown eggs is at a disadvantage when the market to be supplied pays more for white ones.

It is always well in the selection of a breed to consider the ones which are the most popular in the immediate locality, or section of the country, provided they belong to the general type desired. Where a number of breeders are interested in the same breed, it is easier and cheaper to buy good stock. Furthermore, competition increases the chances of success by arousing interest in new practices and methods which will produce results. Besides, when a breed is popular, it usually means that it is well adapted to the economic conditions of that section, such as markets, soil, climate and food supply.

Lastly, and most important of all, the best breed to select is the one in which the breeder takes the most interest. One is seldom successful with a thing he does not like or takes no pleasure in working with.

Scientists generally agree that all the breeds of fowl known

Fig. 8. Jungle Fowl.

at present came originally from the jungle fowls of India (Fig. 8). The jungle fowl can be seen today in the same forests they inhabited many thousands of years ago. These birds are small and unproductive, much like present-day red-game bantams. It seems strange, yet interesting and wonderful, that in the past thirty centuries and more, through the natural forces of food, climate, soil and the influence of man, this race

of fowls could be so varied as to produce all the variations in size, color of plumage and comb, which are seen in modern breeds and varieties of fowl.

Modern breeds and varieties are largely the outcome of crossing the widely-differing fundamental races of fowl. The developing of these new breeds and varieties, with all the different combinations of color in feathering, has been intensely interesting to breeders the world over. In 1873 a number of prominent American and Canadian breeders organized an association called the American Poultry Association for the purpose of standardizing the many breeds and varieties of poultry in America according to their size, shape and color. Since that time the organization has exerted a great influence in developing new breeds and in changing and fixing the appearance of the older ones. With the growth of the industry and the development of the commercial side of poultry-keeping has come a realization of the fact that fowls must have more than good looks to be profitable. This has started a great controversy over the question of the importance of the beauty of fowls as compared with their usefulness in producing food. The radical fanciers are inclined to feel that the useful qualities are incidental to fine appearance, whereas many utility or production breeders think that nothing counts but usefulness. Fortunately most breeders are beginning to see that such radicalism is not justified and that the most can be accomplished by making the useful more beautiful and the beautiful more useful.

THE STANDARD CLASSIFICATION

The American Standard of Perfection[1] classifies fowls according to their appearance. It does not deal with their economic values. At present, including all breeds and varieties, 161 have been recognized. The descriptions and pictures in the Standard are used as guides in judging and breeding fowls

[1] A book published by the American Poultry Association describing the different breeds and varieties.

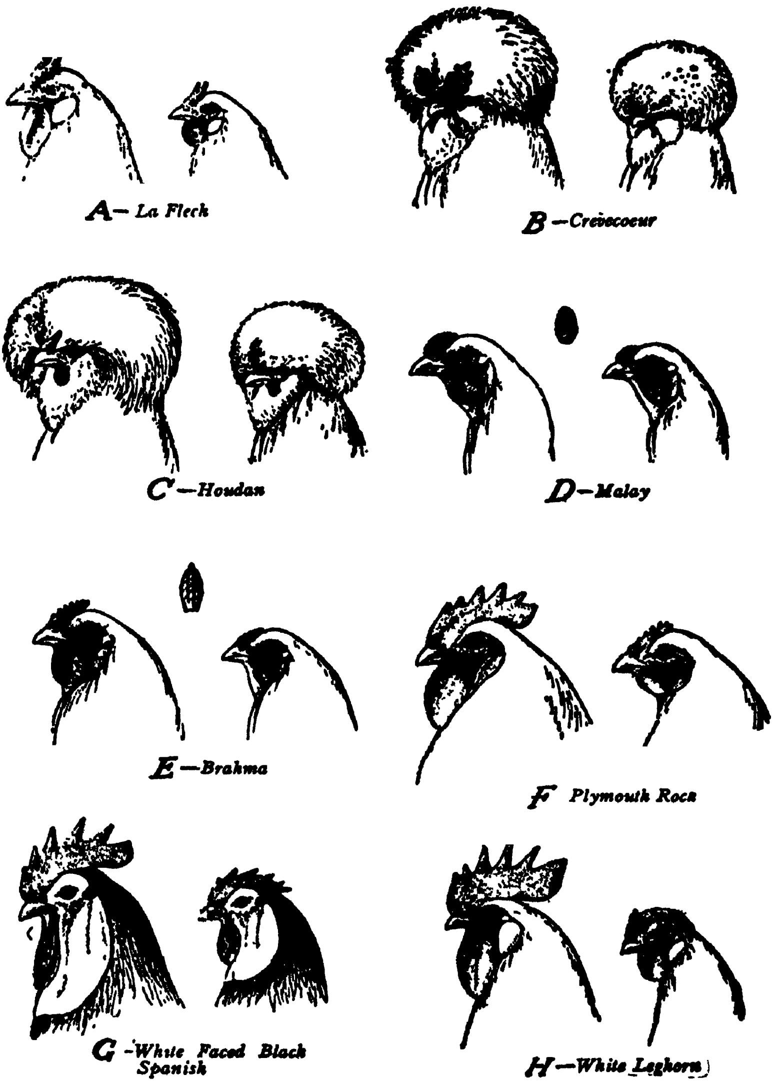


Fig. 9. Types of combs and heads: A, *V-comb La Flèche;* B, *V-comb Crevecoeur;* C, *V-comb Houdan;* D, *Strawberry-comb Malay;* E, *Pea-comb Brahma;* F, *Single-comb Plymouth Rock;* G, *Single-comb White-faced Black Spanish;* H, *Single-comb White Leghorn.*

for exhibition. The Standard divides all poultry into classes, breeds and varieties. The class generally denotes the place or origin; the breed largely the shape and size; and the variety the color marking of the plumage, or type of comb within the breed (Figs. 9, 10). The Standard classification of breeds and their weights are given in the index.

When it comes to the economic consideration of the different breeds and varieties, a different grouping is necessary. This classification is not absolute, owing to the fact that there may be some over-lapping of qualities. However, such a classification is important and interesting for the commercial breeder and especially the beginner, since it is based on the past experience of successful poultry-keepers. Of the many breeds in the classes

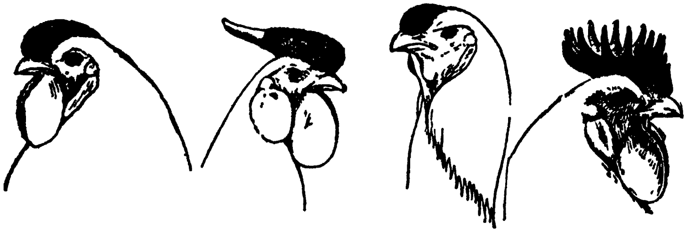


Fig. 10. Rose-comb types. Left to right: Wyandotte, Hamburg, Cushion-comb, Buttercup-comb.

recognized by the Standard of Perfection, there are not only several very similar in general conformation and purpose but some which have characteristics little suited for practical purposes. In making this practical classification, only those breeds which have particular merit will be named and discussed. With this in mind, breeds and varieties of fowl are grouped in classes as follows: (1) The egg breeds; (2) the meat breeds; (3) the general-purpose breeds; (4) the miscellaneous breeds.

THE EGG BREEDS

The breeds most commonly recommended in America for egg production are the Leghorns (Fig. 11), Anconas, Ham-

burgs, Campines and Minorcas. With the exception of the Minorcas, all these breeds are medium to small in size and seem to have developed a natural tendency to lay eggs. As a class, they are active and nervous in temperament, and this, together with their close feathering and alertness, gives them a trim neat appearance. Their natural activeness makes them

Fig. 11. A flock of Single-comb White Leghorns.

good rangers (when they have the opportunity), while on the other hand this inclination to be busy most of the time makes them better able to endure confinement. The egg breeds, being small in size and light in weight, are more inclined to fly. This is considered a handicap by some, especially those who live where it is necessary to keep hens closely yarded. However, very little inconvenience is experienced in this respect, if the owner is always careful not to excite his birds unnecessarily. Of course flying can be stopped by clipping the flight feathers on one wing.

As a group, the egg breeds grow rapidly and begin to lay

when five to six months old. This factor of early maturity is important since it assures a more prompt return on the investment. The cockerels in this class make good broilers, but are unsatisfactory as roasters. The flesh of the hens, although of fairly good quality, has a greater proportion of bone to flesh than is the case with the heavier breeds, and this, together with their small size and the fact that the leading markets discriminate against them, makes them unadapted for meat purposes.

These breeds are not inclined to be broody as a rule, and therefore make poor mothers. The lack of broodiness from the standpoint of production is an advantage, because it allows the hens to lay more steadily. Owing to their small size these breeds are more economical to keep, as they consume less food and need less space in housing. Breeds like the Single-comb Leghorn, being small and close feathered with large combs and wattles, are inclined to be more sensitive to extreme cold, and consequently need ample protection in winter. All the breeds in this group lay white eggs and for this reason are especially adapted for such a fine market as New York City.

Of all the breeds and varieties included in this class, the Single-comb White Leghorn is by far the most popular, commercially. They are raised almost exclusively over large areas along both the Atlantic and Pacific seaboards. Whether in the north, the south, the east or the west, they seem to be able to adapt themselves to any climate well enough to produce eggs very efficiently. This popularity may be partly explained by the fact that it is easier for the busy commercial poultryman to breed white birds than any other color. The brown, buff and black varieties are next in favor.

There are three varieties of Minorcas, the black variety being more commonly bred than the White. Minorcas are the largest breed in this class and also have the reputation of laying the largest eggs of any breed. They have exceptionally large combs and wattles, which makes them much more subject to

freezing. Next to Leghorns, they are the most popular breed in this group.

The Anconas are much like the Leghorns, with the exception of being speckled. They rank next to Minorcas in popularity.

Of the several varieties of Hamburgs, the Silvers are probably the most common. Owing to their peculiar feathering and the tendency to lay small eggs, they are more popular with the fancier than the practical breeder.

Gold and Silver Campines have a great reputation for laying in Belgium, their native country, but have not been very popular in America.

THE MEAT BREEDS

As the name indicates, the breeds in this class are kept primarily for meat purposes. Such breeds as the Brahmas (Fig. 12), Black Jersey Giants, the Cornish, Dorking (Fig. 12) and Sussex, are the most popular in this group. As a rule the meat breeds lay brown eggs, but they are not very good layers, as they have been bred more for size and quality of flesh. Birds in this group often weigh from 12 to 14 pounds alive. Their size and weight makes them slow and clumsy in movement, poor rangers, inclined to be inactive, but quiet and gentle in disposition. They fly with difficulty and are, therefore, easily confined. These large breeds are persistent setters but, due to their size and awkwardness, make poor mothers, for they often trample on their young. The development of a large body takes time, thus the meat breeds are slow to mature and many of the pullets do not lay before eight or ten months of age. These breeds make poor small broilers because of their large bony framework. Later on as roasters and mature birds, their broad deep bodies and well-developed breasts give them a greater proportion of edible flesh and consequently less waste, when dressed, than any other class of fowl. The quality of their flesh is excellent because their natural inactivity keeps

the muscles soft and fatty, and makes the flesh juicy and well-flavored when properly served. However, the breeds in this group have gradually decreased in popularity in recent years.

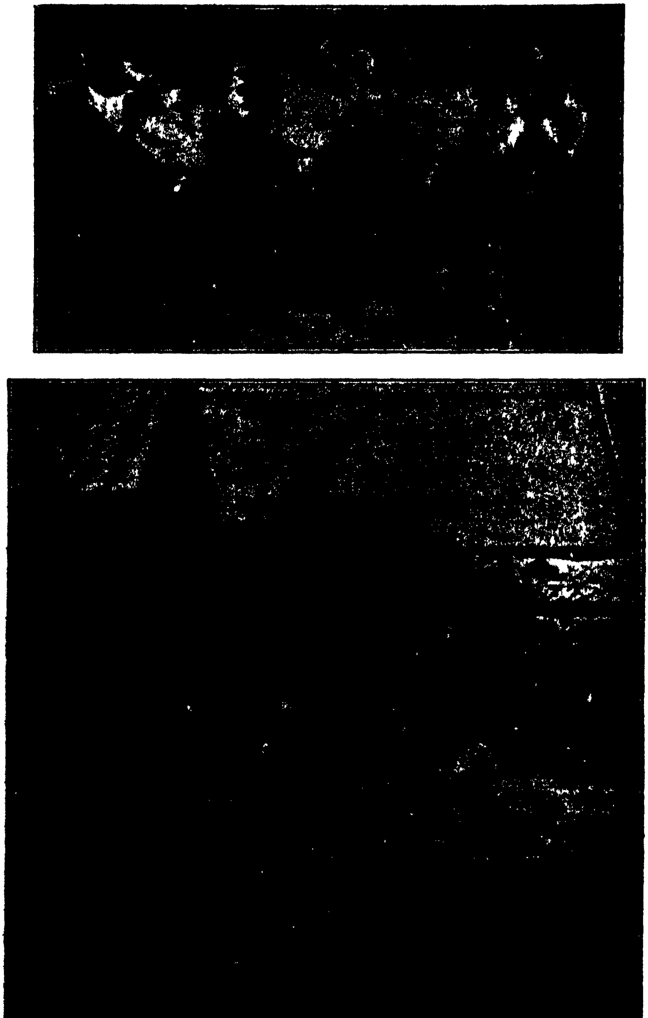


Fig. 12. Above, a flock of Light Brahmas; below, a flock of Dorkings. (*Watson's* Farm Poultry)

The appearance of dressed fowls for market is of great importance because it has much influence on their sale, and care should be taken in choosing a suitable breed. In America, breeds with a nice yellow skin are always selected because the housewife is accustomed to this color, but in Europe, where table poultry has been a specialty for a long period of time, the white-skinned breeds are chosen, as they are considered to have a little finer quality of flesh. Fowls with white or buff-colored feathers dress off cleaner and neater than those of a darker color and for this reason should be given the preference.

The Brahmas are generally considered the leading meat breed. They are very hardy and are excellent as roasters, but slow to mature. Some object to the feathers on the legs and toes, but aside from this they have size, quality and a bright yellow skin which makes them desirable for American market purposes. Furthermore, they lay as well, if not better, than any of the other meat breeds.

The Cornish is a large compact tight-feathered breed with yellow skin. It is excellent for meat purposes because it carries an exceptionally large amount of breast meat. As a breed, it is considered a very poor layer and hatchability is poor.

There are five varieties of Dorking of which the Silver Gray is the most common. This breed belongs to the English class and has a white skin. Edward Brown says that the Dorking "by its fineness of flesh and delicacy of skin, the whiteness of the flesh and legs and the abundance of meat carried upon the body, must be regarded as one of the best table fowls that it is possible to obtain." Dorkings for some reason, probably the color of the skin, have never been very popular in America.

The Sussex is another English fowl much like the Dorking in meat type. There are three varieties, White, Speckled and Red. It is a little smaller than the Dorking and lays a light brown egg. The Sussex is similar to our American breed in size. Its white skin makes it objectionable in American markets, but the superior quality of flesh should make Sussex worthy of

consideration. The Speckled variety is most commonly seen in America.

The Jersey Black Giants are a new American breed which recently has gained great prominence in the eastern part of the United States and especially in the state of New Jersey where they originated. They are the largest breed listed in the American Standard of Perfection. The standard weight of the cocks is 13 pounds and of the hens 10 pounds. Capons of this breed often weigh as much as 15 pounds. Their size, yellow skin, fine meat qualities and absence of feathers on the legs and toes make them superior to the Brahma and probably the best all around meat bird in America today. Owing to their size and origin they are poor layers, however.

THE GENERAL-PURPOSE BREEDS

The breeds in this class are medium in size, excellent layers and fine meat fowls. They combine quality of meat with egg production without sacrificing too much to either. Consequently, they are exceedingly popular with all classes of poultry-keepers, for they fulfill the requirements of the farm flock as well as the large commercial plants. Not only are these breeds popular with the producers and breeders, but with the consumer as well, on account of their fine quality of flesh and size. For the average family, the size and cost of the Brahma fowl is excessive, and on the other hand, a fowl like the average Leghorn sometimes does not carry quite enough flesh to meet the requirements, so a nice fat full-flavored Plymouth Rock or Rhode Island Red fowl weighing between 5 and 6 pounds meets the situation. The dual-purpose breeds are persistent sitters, excellent mothers and mature just about as quickly as the egg breeds. They exercise freely and are good rangers, making them well adapted to general farms where they often pick up a good part of their living. They are favorites in suburban locations because their rather quiet disposition makes them easy to confine. When bred and selected for egg production,

they are fine layers because, having smaller combs and wattles and larger loose-feathered bodies, they are better adapted physically to withstand severe cold weather.

The leading breeds in this class are the Plymouth Rocks

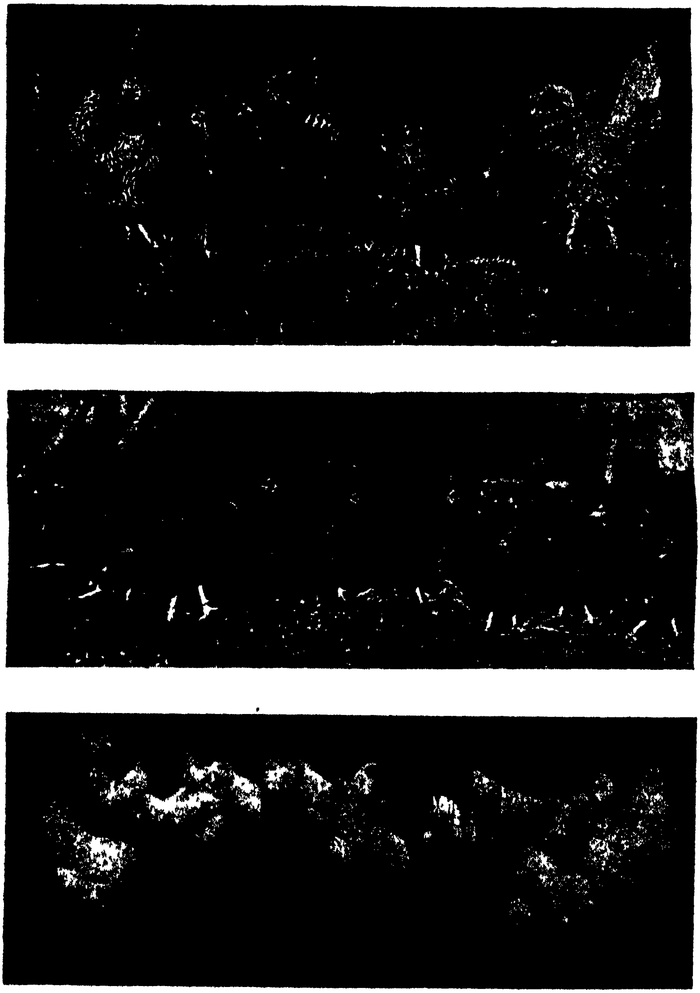


Fig. 13. Above, a flock of Barred Plymouth Rocks; center, a flock of Rhode Island Reds; below, a flock of White Wyandottes.

(Fig. 13), Rhode Island Reds (Fig. 13), Wyandottes (Fig. 13), New Hampshires (Fig. 15), and Orpingtons (Fig. 14). The first four breeds originated in America and are largely the result of crossing Asiatic and Mediterranean types of fowl. This combination of breeds accounts for their yellow skin and brown-shelled eggs.

There are six varieties of the Plymouth Rocks, but only three, the Barred, White and Buff, are kept very generally by farmers and poultrymen. The Barred variety is beyond a doubt the most popular and is kept extensively both on general farms and commercial plants. Plymouth Rocks are very hardy, lay well when bred for production, and make excellent roasters and broilers.

The Wyandottes average a little smaller in size, have rounder and looser-feathered bodies than the Plymouth Rocks. They are also different from the Plymouth Rocks because they have rose combs. This type of comb is considered an advantage by many, since fitting closely to the head, it is less likely to freeze. They lay well when bred for that purpose, but the eggs usually are rather small and vary in color. Wyandottes make particularly fine broilers but have not been popular with poultry-keepers in recent years.

Rhode Island Reds have both single and rose combs and are blocky and rectangular in shape. In color, they are a rich dark red with black tails and some black in the wings. This gives them an unusual color and one which is remarkably beautiful, when bred according to the Standard. Although difficult to breed true to color, they are very commonly kept, and rival the Barred Plymouth Rock in popularity because they are so hardy, lay so well, and are such fine all around meat birds. They lay very large eggs, but are such persistent sitters during the spring and summer that it interferes with their laying considerably. Broodiness, however, has been largely bred out of many of the best strains.

The Orpingtons are an English breed very similar to the American ones already mentioned, except that they are heavier, looser-feathered and have white legs and skin. There are three varieties, White, Buff and Black, but the Whites and Buffs

Fig. 14. A flock of Buff Orpingtons.

are the most popular. Orpingtons are not considered quite as good layers as the Plymouth Rocks, Rhode Island Reds or Wyandottes, but excel them in quality of flesh. For those desiring a little better quality of meat than usual for home use, together with fairly good production, this breed answers the purpose very well. They lay brown eggs of good size, are persistent sitters and good mothers. Having a white skin handicaps them for American market trade.

The New Hampshires are a comparatively new breed having been developed from Rhode Island Reds without the introduction of blood from other breeds. In size they are the same as Rhode Island Reds but their color is much lighter. This breed has gained wide popularity in recent years for its vigor, rapid growth, good feathering, early maturity, and production. When New Hampshire females are crossed with a Barred Plymouth Rock male the resulting offspring make excellent broilers and roasting chickens.

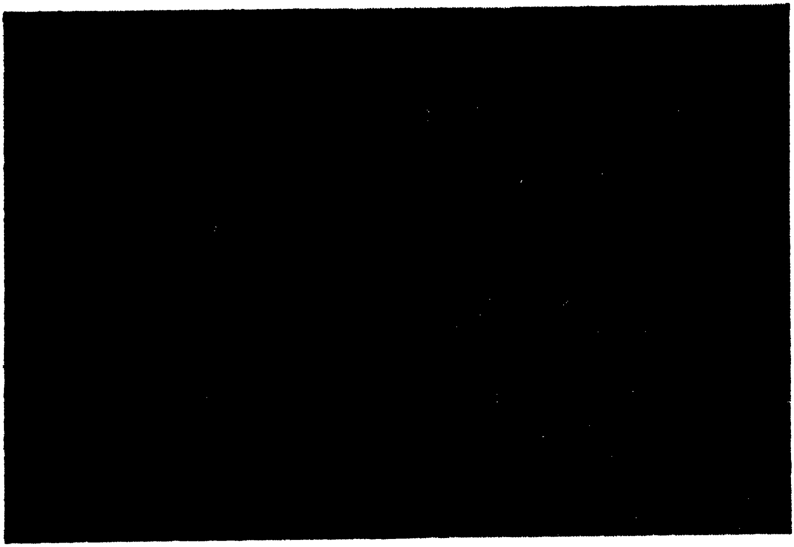


Fig. 15. A flock of New Hampshires.

THE MISCELLANEOUS BREEDS

The breeds and varieties in this group are principally of interest to the fancier or experimenter, for their peculiar feathering and size as well as other odd characteristics make them poorly suited for practical purposes. The breeds of greatest importance are the Polish, Houdans and Favoralles. These breeds, although common on farms in Europe, are not very popular in America.

The Polish breed and its varieties have a large crest on the top of the head as well as fancy plumage. The crest is a nuisance as it interferes with their sight and many times brings on colds when it gets wet. They are also poor layers of small eggs, and being delicate are hard to raise. For these reasons they are scarcely ever bred except for exhibition purposes.

The Houdan and Favoralles are bearded and crested and have a fifth toe. In France, their native country, they are noted for their fine meat qualities and good egg production.

The Silkies, Sultans and Frizzles are breeds only used for

exhibition purposes in America. Each has some peculiarity which makes it interesting when on display.

There are a great many breeds and varieties of Bantams. They are bred for fancy and ornamental purposes entirely. Probably no other class of fowls in the world has given the boys and girls in town and country more pleasure.

CROSS-BRED CHICKENS

In recent years there has been increased interest in crosses between different breeds of chickens because of the increased vigor of the offspring and the possibility of distinguishing the sex of the chicks by the color of the down and feather growth at hatching time. Crossings to determine sex are called "sex-linked." This can only be done with certain breeds.

The vigor resulting from crossing usually results in better hatchability than can be obtained from either of the pure breeds used. The chicks make more rapid growth, live better and egg production may be increased. Egg size usually follows that of the better parent.

Limited observations indicate that the crossing of two unrelated strains of one breed does not produce as good results as the crossing of different breeds.

It is well to keep in mind that in some cases all of the advantages of crossing do not appear. Cross-breeding has several disadvantages, the chief of which are the following: (1) Broodiness is likely to be increased; (2) there are few crosses that produce white eggs; (3) the offspring of such crosses cannot be used as breeders; (4) the advantages of crossing are only in the first generation; (5) lastly, it is necessary each season to secure adequate male and female breeding stock unless chicks are purchased. Good results from cross-breeding can only be expected when reasonably good pure-bred stock is used.

Cross-breds are most commonly grown for the production of table fowl and to a less degree for egg production.

The most popular crosses at present are produced by mating Barred Plymouth Rock males with either New Hampshire or Rhode Island Red females. Reverse crosses are also frequently raised. Crosses in which the Cornish is used make excellent table birds because the good meat qualities of this breed generally appear in the offspring, together with more rapid growth; but hatchability is poor.

The egg production of cross-breds depends on the quality of the parent stock. Usually it is not advisable to keep such birds longer than one laying year, as the second year's production is likely to be much less than the first.

IV. Investment, Returns and Expenses in Poultry Farming

THE capital needed for a poultry farm varies according to the size of the enterprise, the type of business engaged in, the nearness to good markets, the section of the country, the kind and quality of the equipment and the value of the land. Most of these factors have already been discussed in Chapter II.

A typical example of an average commercial poultry farm business in the Middle Atlantic and New England area is given in a survey[1] of 120 poultry farms in New York state for the year ending September 30, 1941. This survey shows that the average capital investment was $17,178 per farm. The average number of layers was 1,192 and the average number of acres in each farm was 90. Eighty of the 120 farms had White and Buff Leghorns, the rest kept heavy breeds like the Rhode Island Red, New Hampshire or crossbreeds. The farms surveyed were located in the central and eastern part of New York state. The distribution of the capital investment is given in Table I.

The figures in this table indicate that the average value of the dwelling houses on these farms amounted to about $3,600, or about one-fifth of the total investment. The total real estate amounted to about $11,000 or two-thirds of the capital invested. The average value of the poultry buildings was $2,858, while the total investment in poultry buildings, poultry equipment and poultry amounted to about $5,500, or about one-third of the total farm investment.

[1] The data and most of the explanation of this survey are taken from "Commercial Poultry Farming in New York." By Lawrence B. Darrah. Mimeographed report, Agricultural Economics 398. July, 1942. Department of Agricultural Economics. New York State College of Agriculture, Ithaca, N. Y.

TABLE I

AVERAGE CAPITAL PER FARM

(120 poultry farms, New York, 1940–41)

Item	Average Capital per Farm	Proportion of Total
	Dollars	*Per cent*
Dwellings	3,598	21
Poultry buildings	2,858	17
Other buildings	1,812	10
Land	3,032	18
Total real estate	11,300	66
Poultry equipment	624	4
Other equipment	1,359	8
Poultry	2,059	12
Other livestock	1,126	6
Feed and supplies	710	4
Total capital	17,178	100

POULTRY FARM INCOME

The average income on the 120 farms is given in Table II. This table shows that the average receipts for each farm was $8,993. Egg sales amounted to slightly over half of this figure, or $4,596, while poultry meat sales accounted for $972, or

TABLE II

AVERAGE RECEIPTS PER FARM

(120 poultry farms, New York, 1940–41)

Item	Average Receipts per Farm	Proportion of Total
	Dollars	*Per cent*
Eggs sold	4,596	51
Baby chicks sold	378	4
Poultry sold	972	11
Crops sold	793	9
Other livestock sold	208	2
Other livestock products sold	975	11
Work off farm	214	2
Net increase in inventory	768	9
Other receipts	89	1
Total	8,993	100

11 per cent of the total sales. The receipts from eggs, baby chicks, and poultry meat made up about two-thirds of the total yearly income. Other livestock products, consisting primarily of milk and milk products, averaged $975 per farm. Income off the farm averaged $214 per farm.

The net increase in inventory amounted to $768 per farm, or 9 per cent of the total farm receipts. This item reflects the higher costs of raising pullets in 1941 as compared with 1940.

POULTRY FARM EXPENSE

The items of expense given in the above survey are typical of what can be expected in operating a poultry farm. A list of them is given in Table III.

TABLE III

AVERAGE EXPENSES PER FARM

(120 poultry farms, New York, 1940–41)

Item	Average Expenses per Farm	Proportion of Total
Poultry feed	3,092	47
Other livestock feed and hay	348	5
Hired labor and board	785	12
Unpaid family labor	203	3
Poultry purchased	214	3
Other livestock purchased	85	1
New buildings and building repairs	334	5
New equipment and equipment repairs	261	4
Auto, truck, and tractor cost	364	6
Taxes	143	2
Farm insurance	42	1
Lime and fertilizer	101	2
Seeds	47	1
Other farm expenses	514	8
Total	6,533	100

This table shows that excluding the value of the operators time and interest on the money invested in the farm, the average farm expenses were $6,533. Feed was the largest single item. It amounted to $3,092, or 47 per cent of the total farm expenses. This percentage of total cost is similar to results

obtained in other surveys in New York state and in other states. Hired labor cost $785, while unpaid family labor amounted to $203. Feed and labor combined amounted to about two-thirds of the total farm expense.

OPERATOR'S NET INCOME, OR LABOR INCOME

In comparing poultry-farm businesses, or the efficiency of the operator, it is common practice by economists in New York state and other states to do so on the basis of the net returns to the operator after all farm expenses are paid. In other words, *labor income* is the pay a farmer receives for his labor and management, in addition to the use of a house and farm products after paying all business expenses of the farm and after deducting a charge for the capital invested. The farm products include eggs, milk, vegetables and other products for the family living. The average labor income for the 120 farms is given in Table IV.

TABLE IV

AVERAGE LABOR INCOME

(120 poultry farms, New York, 1940–41)

Item	Average per Farm
	Dollars
Total capital	17,178
Total farm receipts	8,993
Total farm expenses	6,533
Farm income	2,460
Interest on average capital at 5 per cent	859
Labor income	1,601
Farm privileges	429
Operator's labor earnings	2,030

The farm income was $2,460 per farm. The interest on the average capital of $17,178 amounted to $859, leaving the average labor income at $1,601.

The average estimated value of the privileges per farm was

$429. This sum when added to the labor income of $1,601 gives a total labor income of $2,030.

Labor income, of course, varies from year to year with economic conditions. It may also vary according to the business ability of the operator and whether he applies certain fundamental factors to the conducting of his poultry business.

FUNDAMENTAL FACTORS IN THE BUSINESS MANAGEMENT OF A POULTRY FLOCK

Studies of poultry-farm businesses in many states as well as in New York state have been made, to find the factors essential for the operation of a successful enterprise. In general, these findings indicate that at least five things have an important bearing on the amount of the labor income of an operator. They are: (1) number of layers per farm, or the size of the business; (2) the average number of eggs produced per hen; (3) the per cent of production during the fall months (Sept.–Dec.); (4) time spent in caring for a certain number of birds; and (5) the death rate in the flock.

NUMBER OF LAYERS PER FARM, OR SIZE OF BUSINESS

Table V shows how number of layers affected the labor income. For farms with less than 700 layers the average labor

TABLE V

NUMBER OF LAYERS AND LABOR INCOME

(120 poultry farms, New York, 1940–41)

LAYERS	FARMS	AVERAGE LAYERS	AVERAGE LABOR INCOME
Number	*Number*	*Number*	*Dollars*
Less than 700	40	530	798
700–1,299	40	931	1,531
More than 1,299	40	2,114	2,475
Total or average	120	1,192	1,601

income was $798, while for those having more than 1,299 the average was $2,475. Frequently poultry farmers increase the

size of their farm business by selling baby chicks or by growing broilers or other meat birds.

Large businesses are much more efficient in the use of labor and capital if well managed. On the other hand, a large business carries with it the disadvantage of danger of a large loss. It is dangerous for an individual to increase his flock or size of business until he is reasonably certain of his ability to control problems such as rate of egg production and mortality. Large size of business is a real gamble for one who is inexperienced and who does not know from long experience about how efficiently he can produce eggs and poultry.

EGGS PER HEN

The number of eggs produced per hen is a very important factor affecting the labor income, as is shown in Table VI.

TABLE VI

EGGS PER HEN AND LABOR INCOME

(120 poultry farms, New York, 1940–41)

Eggs per Hen		Farms	Average Labor Income
Range	Average		
Number	*Number*	*Number*	*Dollars*
Less than 160......	143	44	1,289
160–179...........	171	39	1,665
More than 179.....	195	37	1,905

For the 44 farms in Table VI producing less than 160 eggs per hen, the labor income was $1,289. As the rate of production increased, the labor income increased. Thus, for the farms producing more than 179 eggs per hen, the labor income was $1,905. The higher cost of producing more eggs was more than offset by the increased returns.

The average of five previous surveys in New York state showed that $176 was added to the income for each increase of a dozen eggs per hen.

PER CENT PRODUCTION DURING THE FALL MONTHS

In general, Table VII shows that the farms having more than 40 per cent lay in the high-egg-price period of October to December made a larger labor income than did those with less than 40 per cent lay in the same period.

TABLE VII

NUMBER OF LAYERS, PER CENT LAY OCT.–DEC., AND LABOR INCOME
(120 poultry farms, New York, 1940–41)

Layers	Less than 40 Per cent Lay Oct.–Dec.		More than 40 Per cent Lay Oct.–Dec.	
	Farms	Labor Income	Farms	Labor Income
Number	*Number*	*Dollars*	*Number*	*Dollars*
Less than 700	24	663	16	999
700–1,299	21	1,431	19	1,642
More than 1,299	24	2,511	16	2,421

The relationship is obscured somewhat in this survey in the flocks with more than 1,299 layers, because a large proportion of the farms of this size were engaged in the hatchery business and purposely gave their breeders about a two-month rest period in the fall. As a result of the hatchery business, the added income from this source more than offset the lower fall egg production. Previous surveys over a five-year period in New York state have shown that for each one per cent increase in the rate of production during October, November and December, the labor income was increased $51.

LABOR EFFICIENCY

Work units per man, or the time spent in caring for a certain number of birds, is a good measure of labor efficiency in operating a farm. A work unit[2] in this case is the work accomplished by one man in a 10-hour day.

The efficiency of the farm is determined by dividing the

[2] Work units per farm are determined as follows: Hens, per 100 birds = 20 work units yearly. Pullets raised, per 100 birds = 5 work units yearly.

were up to the average, to $2,552 on farms having three factors average or better.

Since each of the five factors, size of business, eggs per hen, number of fowls per man, percentage of fall production, and death rate, is important in determining the success of the business, it follows that the poultryman who has a large flock and a large number of fowls per man, obtains good egg production with a high rate of production in the October–December

TABLE XI

RELATION OF NUMBER OF IMPORTANT BUSINESS FACTORS AS GOOD AS, OR BETTER THAN, THE AVERAGE TO LABOR INCOME, FIVE YEARS 1929–33

Number of Factors Average or Better	Records	Layers	Birds per Man	Eggs per Hen	Proportion of Lay October–December	Proportion of Mortality, Beginning Number	Cost of Eggs	Labor Income
	Number	*Number*	*Number*	*Number*	*Per cent*	*Per cent*	*Cents*	*Dollars*
	Farms selling chicks							
None...	18	943	477	128	16.0	25.9	39.9	366
One.......	56	982	523	125	17.8	19.9	41.0	639
Two.....	80	1,343	694	144	21.8	22.3	34.9	995
Three.....	93	1,655	740	148	26.6	17.7	33.1	1,773
Four......	42	2,003	918	155	28.2	16.9	32.1	2,424
Five......	15	2,698	958	166	28.3	14.8	29.8	4,912
Total.	304	1,521	714	144	23.4	19.7	35.0	1,514
	Farms not selling chicks							
None.....	21	736	489	117	18.9	29.7	43.8	62
One.......	54	816	515	127	19.3	19.8	36.3	373
Two......	76	1,035	634	148	23.6	19.4	31.1	723
Three.....	93	1,156	736	157	29.4	15.6	29.9	1,051
Four......	39	1,562	888	161	32.7	19.0	27.8	1,623
Five......	13	2,023	1,166	178	34.8	12.8	25.8	2.923
Total.	296	1,139	691	148	26.0	18.6	31.8	945

period, and loses less than the average number of birds, is in position to make a favorable labor income.

Misner and Lee [3] discuss the importance and effect of these factors in a study which they made of five-year records taken

[3] Cornell University Agr. Exp. Sta. Bul. 684.

on New York poultry farms ending in 1933. Their report states:

"When no chicks were sold, the farms with none of the above features of the business as good as the five-years average, returned an average labor income of $62. The farms with any one, but only one, factor average or better made a labor income of $373. Farms with two factors average or better made labor incomes of $723; those with three made $1,051; those with four made $1,623; while those with all factors average or better made an average labor income of $2,923 for the five years. When no chicks were sold, 7 per cent of the farms had no factors as good as or better than the average.

"The relation of the number of factors average or better than the average, to the labor income, where chicks were sold and where no chicks were sold, is shown in Table XI.

"When chicks were sold, the farms with the number of factors here indicated as *average or better* had labor incomes as indicated: none, $366; one, $639; two, $995; three, $1,773; four, $2,424; five, $4,912.

"Of 304 records on farms selling chicks, 15, or 5.0 per cent, and of 296 records on farms not selling chicks, 13, or 4.4 per cent, were as good as or better than the average in all five factors. Of all who try the poultry business, only 5 per cent are as successful as the average poultryman in five important matters of poultry-farm organization. These men do well financially."

THE COST OF RAISING PULLETS

The cost of stock replacements is an important item on a poultry farm and is one in which every poultry keeper is interested. If the cost of raising a pullet is high it decreases the labor income, but if it is low it increases it. Feed, labor, cost of the chicks, and mortality are important factors in the cost of growing pullets. Feed is the largest single item and usually makes up about half the cost. Figures[4] on the cost of growing pullets on 115 farms in New York state in 1940–41 show that

[4] From "Commercial Poultry Farming in New York." By Lawrence B. Darrah. Thesis, Cornell University Library. Jan., 1943, p. 61. Explanations are from the author for the most part.

feed amounted to 46.2 per cent of the cost; chicks, 21.7 per cent; man and home labor, 17.5 per cent; use of auto, truck and tractor, 2 per cent; use of land, buildings, and equipment, 7.2 per cent; interest, 1.7 per cent; miscellaneous, 3.4 per cent. Three items, feed, chicks, and labor, accounted for 85.4 per cent of the total cost of raising a pullet.

Other factors affecting the cost of pullets are the breed and sex of the chicks, and whether straight-run or sexed pullets are raised. Table XII gives some interesting information on these points.

"For pullets raised from straight-run chicks, the net cost per pullet was 6 cents higher for the light than for the heavy breeds. On the other hand, the net cost of raising pullets from sexed-pullet

TABLE XII

RELATION OF SEX AND BREED OF CHICKS TO COST OF RAISING PULLETS
(80 poultry farms, New York, 1940–41)

Item	Straight-run Chicks		Sexed-pullet Chicks	
	Light Breeds	Heavy Breeds	Light Breeds	Heavy Breeds
Number of farms	30	14	25	11
Chicks started per farm	2,881	2,180	1,214	1,291
Pullets raised per farm	1,071	721	1,000	952
Per cent mortality	18.4	16.6	12.2	8.6
Feed per pullet raised	31.4 lb.	39.2 lb.	23.1 lb.	31.0 lb.
Labor per pullet raised	38 min.	59 min.	32 min.	39 min.
Costs:				
Feed	$0.67	$0.90	$0.51	$0.69
Labor	0.27	0.37	0.22	0.26
Chicks	0.33	0.32	0.28	0.24
Use of buildings and equipment	0.09	0.10	0.06	0.08
All other costs	0.13	0.20	0.12	0.10
Total	$1.49	$1.89	$1.19	$1.37
Returns, other than pullets raised:				
Cockerels	$0.45	$0.90	$0.03	$0.03
All other returns	0.02	0.03	0.01	0.02
Total	$0.47	$0.93	$0.04	$0.05
Net cost per pullet	$1.02	$0.96	$1.15	$1.32

chicks was 17 cents lower per pullet for the light than for the heavy breeds.

"Factors that explain the increased cost of raising heavy breed pullets from sexed-pullet chicks are: (1) The longer period of time required for growth to maturity, (2) The heavier feed consumption during growth, and (3) The fact that the heavy breeds generally require more floor space for a given number of birds than do the light breeds. The same factors apply for pullets raised from straight-run chicks, but the high return from the sale of heavy breed cockerels offset the total cost to the extent that the net cost of the heavy breed pullets was less than the light breed pullets."

A COMPARISON OF LIGHT VS. HEAVY BREEDS

In Table XIII the breeds kept on the 120 poultry farms in New York state previously mentioned in this chapter have

TABLE XIII

A Comparison of Breeds on 120 Poultry Farms, New York (1940–41)

Item	Light Breeds	Heavy Breeds
Number of farms	80	40
Number of layers	109,520	33,518
Average number of layers	1,369	838
Per cent of pullets in the flock	60.3	79.4
Eggs produced per layer	168	167
Weight of bird	4.2 lbs.	5.8 lbs.
Selling price per pound	15.2 cents	18.6 cents
Ave. price received per bird	$.63	$1.08
Size of eggs	Same for both breeds	
Ave. price received for market eggs	28.8 cents	27.6 cents
Disposal of eggs		
Wholesale	60.7%	31.1%
Retail	14.1%	32.6%
Hatching	1.7%	11.1%
Mortality of ave. number	26.5%	20.6%
Hours of labor per bird	2.2	2.6
Feed consumption		
Grain	46.0 lbs.	49.9 lbs.
Mash	44.7 lbs.	54.6 lbs.
Other feed	4.3 lbs.	3.3 lbs.
Total feed	95.0 lbs.	107.8 lbs.
Quantity of feed per dozen eggs produced	6.9 lbs.	7.9 lbs.

been divided into two groups, (1) the light breeds, which include only White and Buff Leghorns, and (2) the heavy breeds,

which include the Rhode Island Reds, New Hampshires, Barred Plymouth Rocks, White Plymouth Rocks and Rock-red and Red-rock crosses.

Table XIII shows that the average egg production and size of the eggs was practically the same for both light and heavy breeds.

The average price for all white market eggs sold was 28.8 cents per dozen. This was 1.2 cents higher than the average price of 27.6 cents received for all brown eggs.

Large white eggs sold for 1.6 cents more per dozen than the large brown eggs. The differences in prices received for jumbo and medium grades, although small, favored the white eggs. White pullet eggs sold for about a cent higher than the brown pullet eggs.

Aside from the eggs sold locally, most of the eggs of either color were sold in the New York market, where white eggs are favored. If these eggs had been sold in New England markets, where brown eggs are preferred, the price differences would probably have been reversed. This comparison is still further influenced by the fact that a larger proportion of brown eggs than of white eggs were sold at retail and for hatching. These eggs sold for higher prices per dozen than wholesale market eggs. This tends to narrow the actual margin that exists between white and brown eggs on the New York market.

The heavy breeds returned more when sold for meat than the light breeds. They averaged 1.6 pounds heavier and brought 3.4 cents more per pound, or 45 cents more per bird.

The average mortality for all breeds was 25 per cent of the average number of layers. The mortality of the light breeds was 26 per cent of the average number of layers, while the heavy breeds averaged 20.6 per cent.

The heavy breeds required 2.6 hours of labor per bird, while the light breeds required 2.2 hours. The difference of .4 hour per bird was due to three things: (1) the time required to deliver a larger proportion of eggs at retail, and in dressing and de-

livering birds sold as meat; (2) differences in the average number of layers per farm, since the light-breed flocks were larger; and (3) the fact that more light-breed layers were kept in a given amount of floor space than heavy-breed layers.

On the average, the heavy breeds consumed about 13 pounds more feed than did the light breeds, or, in other words, it took a pound more feed to produce a dozen eggs. The amount of feed consumed, of course, depends on the size of the birds and the rate of egg production.

In comparisons like those in Table XIII, no definite conclusion can be drawn because of the many conflicting factors which affect the results. Nevertheless, the information is worthy of consideration. Markets, section of county, likes and dislikes of the operator, and salesmanship, all enter into the choice of a breed of poultry and influence the success of an enterprise. The above data do indicate that there is very little difference in egg production, when the breeding and care is good, between Leghorns and the commonly kept heavy breeds. There was a significant difference in mortality and in feed consumption.

V. Poultry-House Construction

WHEN properly constructed and managed, a good poultry-house is a valuable aid in keeping a flock of hens healthy and vigorous. Its cheerfulness and comfort are also important because these factors affect production. The proper kind of house will increase the profits by saving labor and adding to the annual egg production, and will be a source of satisfaction and pride to the owner.

An ideal location for a poultry-house is on a well-drained slope facing the south near an orchard or a piece of timberland, where there is shelter from prevailing winds at all times and shade in summer. A location midway up such a slope is best because the hill top is usually wind-swept and the lower places are cold and damp.

It is advisable to locate the house on land that is easily tilled and allow for a range in the rear as well as in the front. Such a double-yard system is an advantage because it not only permits the land to be cropped and used for a range, but it helps to keep the soil cleaner and more sanitary near the buildings.

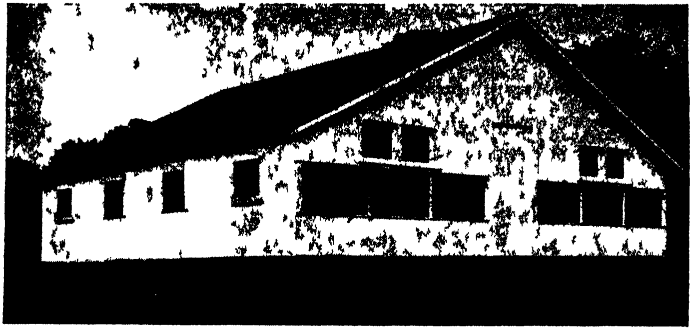
The poultry-house should be placed conveniently near the other farm buildings so that the feed and water supply are easily accessible, but should not be so close to the residence that the noise, dust and odor from the hens will be a nuisance.

Lastly, the house should be placed so that additions to the building or to the land and yards can be made in the future, if necessary, without undue expense in moving or remodeling.

ESSENTIAL FEATURES OF A POULTRY-HOUSE

Ventilation. Proper ventilation is one of the most important factors in promoting the comfort and health of a flock of hens. The relationship between poor ventilation, damp litter and

moisture in a poultry-house is not generally understood. Too often the type of ventilation adapted to other farm animals is



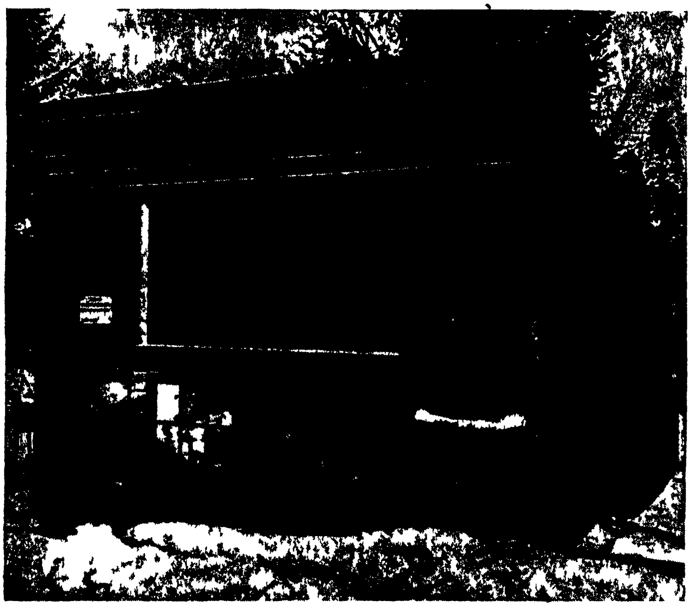


Fig 16 Above, the Missouri type of barn hen-house. This building has a straw loft and is 30 feet wide and 40 feet long. Below, a small poultry-house, 12 feet square, suitable for a flock of thirty-five hens

applied to houses built for hens. No thought is given to the way in which hens differ from mammals. Hens have a higher

temperature, breathe much faster, and have no sweat glands nor liquid discharge from the kidneys. Under these conditions, not only are larger amounts of moisture thrown off in breathing, but more oxygen is required for each pound in weight every twenty-four hours than for other live-stock. According to King, the amount of fresh air necessary each twenty-four hours for 1,000 pounds live weight of each of the following, is:

Man	2,833 cubic feet
Cow	2,804 cubic feet
Horse ...	3,401 cubic feet
Hens ...	8,278 cubic feet

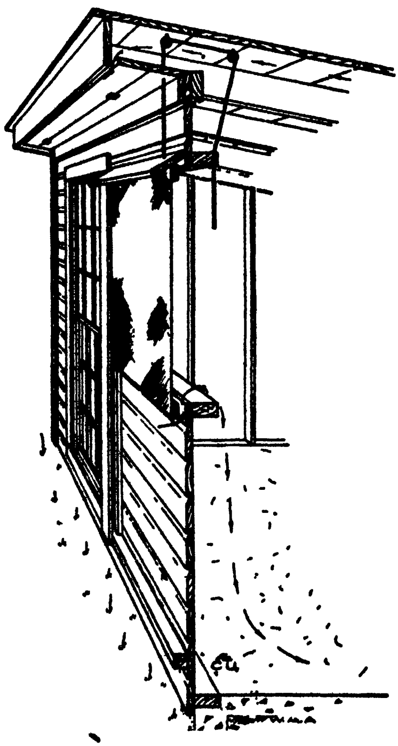


Fig. 17. Details of the rafter ventilation system. Note the set-out curtain intake and the front-rafter ventilator outtake. The outlet ventilator should extend the whole length of the house. The trim board on the front of the rafters should extend down to the bottom of the ventilator door. The ventilator door should be kept either completely open or completely closed as indicated. (Courtesy of Agr. Eng. Dept., Cornell Univ.)

Good ventilation consists of a continuous circulation of air into and out of a building.

This movement of air may be brought about naturally, if the proper ventilator openings are made, by the difference in temperature between the inside and the outside air, for it is a scientific fact that any volume of warm air weighs less than the same amount of cold air. The colder outside air on entering the house sinks to the floor, but begins to rise when warmed by the animal heat thrown off by the birds, and this continuous current of air moving through the house picks up and carries away

TABLE XIV[1]

DIMENSIONS OF OUTLET FLUES FOR COLD OR WARM PENS OF VARIOUS SIZES; HEIGHT OF VENTILATOR HEAD OPENING FOR CHIMNEYS WITH ONE, TWO, THREE, OR FOUR FLUES; AND NUMBER OF INLETS FOR EACH PEN

Floor Area of Pen	Size of Outlet Flue	Height of Opening *H* in Ventilator Head; Single Flue (See Figure 22, Page 62)	Height of Opening *H* in Ventilator Head Two-Flue Chimney	Height of Opening *H* in Ventilator Head Three-Flue Chimney	Height of Opening *H* in Ventilator Head Four-Flue Chimney	Inlet Flues (Each About 60 Square Inches in Area)
A	*B*	*C*	*D*	*E*	*F*	*G*
Square feet	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Number*
540 or less	16 x 16	8	10½	12	13	4
540 to 615	16 x 18	8	11	12½	13¾	5
615 to 685	18 x 18	9	12	13	14½	5
685 to 760	18 x 20	9	12½	14	15	6
760 to 840	20 x 20	10	13	15	16	7
840 to 925	20 x 22	10	13½	15½	17	7
925 to 1,010	22 x 22	11	14	16	17½	8
1,010 to 1,105	22 x 24	11	14½	17	18	9
1,105 to 1,200	24 x 24	12	16	18	19½	10
1,200 to 1,300	24 x 26	12	16½	19	20	10
1,300 to 1,405	26 x 26	13	17	19½	21	11
1,405 to 1,510	26 x 28	13	17½	20	22	12
1,510 to 1,620	28 x 28	14	18½	21	22½	13
1,620 to 1,740	28 x 30	14	19	22	23½	14
1,740 to 1,860	30 x 30	15	20	22½	24	15
1,860 to 1,980	30 x 32	15	20½	23	25	16
1,980 to 2,120	32 x 32	16	21	24	25½	17
2,120 to 2,240	32 x 34	16	21½	25	26½	18
2,240 to 2,390	34 x 34	17	22½	25½	27½	19
2,390 to 2,515	34 x 36	17	23	26	28	20
2,515 to 2,665	36 x 36	18	24	27	29	22
2,665 to 2,815	36 x 38	18	24½	28	29½	23
2,815 to 2,965	38 x 38	19	25	28½	30½	24
2,965 to 3,110	38 x 40	19	25½	29½	31	25
3,110 to 3,290	40 x 40	20	26½	30	32	27
3,290 to 3,430	40 x 42	20	27	30	32½	28

moisture from the building. This process of removing moisture is easily explained. When the temperature of air is raised, its capacity for holding water is increased. In other

[1] From Cornell Extension Bulletin 315.

words, it becomes "thirsty" for water; so it absorbs moisture from the air, litter and droppings. If the warmed moisture-laden air can escape quickly from the room before it is cooled, this moisture will be carried away with it. It is very important, therefore, to have a definite and adequate way for air to enter and be discharged from the building. Furthermore, the incoming fresh air should be so controlled and directed that it will not cause drafts or retard the escape of used air.

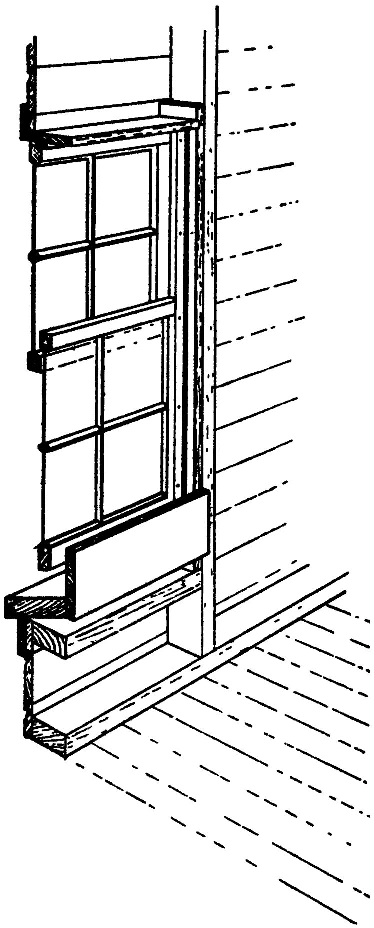


Fig. 18. Cross section of window inlet. The window sill extends clear to the baffle board so that wind cannot blow down to nor across the floor. A wire-netting guard may be placed over the inlet to prevent the birds from roosting on it. (Courtesy of Agr. Eng. Dept., Cornell University.)

VENTILATION SYSTEMS

The most common types of ventilation now in use in poultry-houses are the open-front, rafter, and flue systems.

The open-front. The open-front system of ventilation is in use extensively in all climates. It consists of large openings in the front near the ceiling or roof to let out the warm, moist air which rises. In cold sections, or exposed windy locations, the front openings are covered with muslin or glass substitutes on movable frames, so that the size of the opening can be regulated according

to the weather and the season of the year for best results.

The rafter system. The rafter system of ventilation is used principally in shed-roof buildings, and consists of an opening between the rafters in the front which acts as an outtake. The size of the outtake opening is controlled by a hinged door under the ends of the projecting rafters. A similar opening is recommended in the rear for summer use.

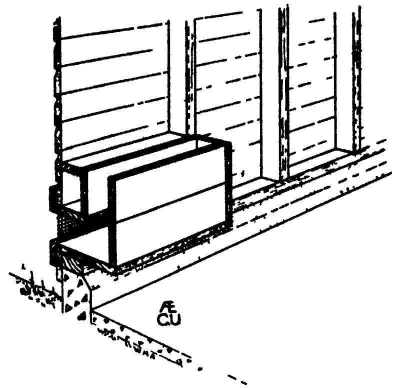


Fig. 19. Built-in intake. Built-in intakes should extend entirely inside the frame. Inlets of this type may have a wire netting guard to prevent the birds from roosting on them. No inlet should be within 8 feet of the outlet flue. (Courtesy of Agr. Eng. Dept., Cornell University.)

The intake for this system can be arranged in any one of three ways: (1) by setting the front curtain frame out one inch from the front of the house (Fig. 17); (2) by raising the window sash 1½ to 3 inches, depending on the width of the sash (Fig. 18); (3) by built-in openings (Fig. 19). The area of the opening should be about 60 square inches, with either of the last two types of intakes. When the window is used, a wide baffle board is nailed across the window frame on the inside to prevent drafts on the floor.

The flue system. The flue system of ventilation consists of a flue outlet which opens at the ceiling or high point (Fig. 20) in the pen in cold houses, and 12 to 15 inches above the floor in a warm house (Fig. 24). The intakes in either case may be arranged in the same manner as in the rafter system (Figs. 17, 18, 19).

Dimensions of the flues for either the cold or the warm house are the same. (See Table XIV.)

A cold house is one in which the temperature frequently

drops below freezing during the winter, due to lack of insulation; a warm house is one in which the temperature is usually above freezing.

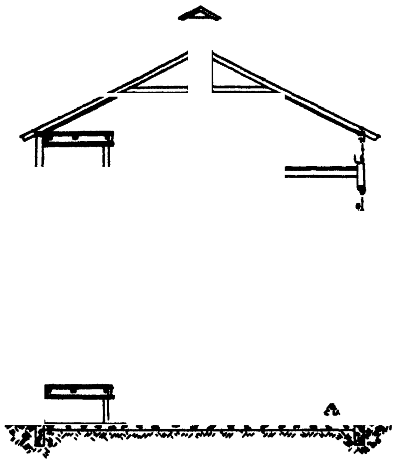


Fig. 20. The flue system of ventilation for a cold multi-story poultry house. Window intakes are on the side facing the south. This arrangement is desirable for buildings not more than 24 feet wide. For buildings more than 24 feet wide inlets as described in Fig. 19 may be used under the dropping boards in addition to the window inlets in the front. Buildings 34 or 36 feet wide may have windows on both sides with the dropping board and perches in the center. (Courtesy of Agr. Eng. Dept., Cornell University.)

When the flue system is used, several rules must be observed as follows: (1) a separate flue should be provided for each pen; (2) the outtake flue should extend two feet above the highest part of the building (Fig. 22); (3) there should be no openings into the sides of the flue from pens through which the flue passes; (4) the flue must be well insulated (Fig. 21); (5) the flue should be made the full size for the floor area; (6) no inlet should be within eight feet of the outlet chimney.

The smallest flue size in Table XIV is 16 x 16 inches. A smaller flue than this is not advisable even though the floor area may be less than 540 square feet. Too small a flue results in greater chilling of the air in the flue and consequent failure in circulation.

Operation of ventilating systems. The operation of the rafter system is easy. The front rafter ventilator door (Fig. 17) is made so that when it is closed there is a 1-inch opening across the front of the house. In cold weather (below freezing) this door is closed. At such times the foul moist air from the pen escapes through the 1-inch opening and the wind cannot blow into the house and cause drafts.

The function of the sliding cloth frame (Fig. 17) is to protect the pen in cold, stormy weather. On quiet, bright, sunshiny days in winter it may be opened, but it should be closed in bad weather. During the late fall, winter and early spring, the curtains should be closed at night to protect the birds from sudden storms. Considerable judgment is necessary in adjusting the curtain for all conditions of temperature, weather and season.

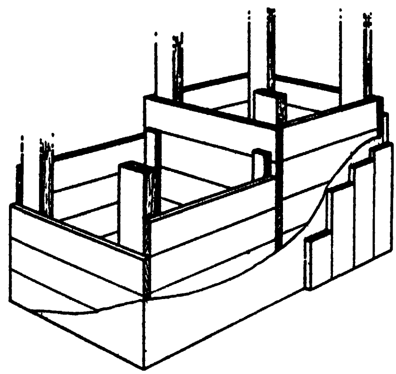


Fig. 21. Construction details of a chimney for a multi-story house. The 1 x 2 inch furring strips nailed to the side of the chimney from a lower floor serve as corner posts for the flue at the left. The posts in the outer corners are made from 2 x 4's. Note the double boarding with paper between. The flue must be well insulated to work well. A single flue is constructed as shown on the right. (Courtesy of Agr. Eng. Dept., Cornell University.)

The flue system of ventilation usually does not need much attention from late fall to early spring. Usually no change needs to be made in the window openings or ventilators during this period.

The movement of air within the poultry-house does not depend on the ventilating system in the summer time, but upon opened windows on two or more sides of the building, which permits cross-ventilation. The windows opened will depend on the direction of the prevailing winds.

Economy of construction. Poultry-houses need not be elaborate and expensive to be comfortable for hens. They should be built as cheaply as is consistent with good construction. Many houses cost much because they have not been planned properly. A fancy finish and frills only add to the cost without increasing the efficiency.

Some poultry-houses are built needlessly high, or narrow and long, while others have unnecessary alleyways or partitions and miscellaneous equipment which occupies so much of

the floor space that the capacity of the house is reduced. These items not only make the cost of housing a hen greater, but they may interfere with the comfort of the hens as well.

Durability. It pays to use good materials and workmanship in building poultry-houses, for they are usually a permanent part of the farm buildings. Cheaply built houses are expensive in the end, for they soon have to be replaced. The roof, in particular, should be strong enough to withstand heavy snow and windstorms.

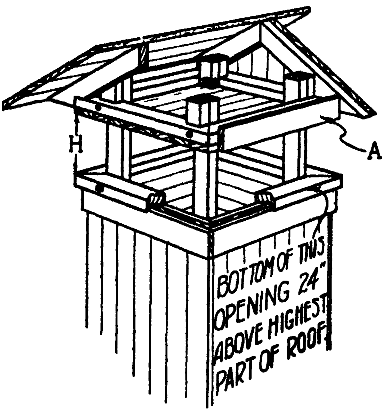


Fig. 22. The outtake-flue head for a single-flue chimney. The flat insulated ceiling in this head is essential. It should be insulated. The height of opening H is given in column C in table XIV on page 57. The board A prevents wind from blowing through the top of the head. The bottom of the opening should be at least 2 feet above the ridge of the roof. (Courtesy of Agr. Eng. Dept., Cornell University.)

Sunlight. In poultry-house construction, provision should be made for an abundance of sunlight.

By facing the house toward the south and having the windows or openings high in the front, the sun will reach a large part of the inside of the house each day in the year. Sunlight is not only an excellent disinfectant, but through the violet rays it supplies the anti-rachitic factor which is so necessary for the health and development of poultry. Sunlight warms the house in winter and makes it more cheerful and pleasant at all times. Sunshine is a better egg producer and tonic than any of the condimental foods on the market.

Protection against destructive animals. Rats, mice, minks, weasels and skunks are common pests on every farm and are likely to cause large losses if they can find suitable hiding places. Their favorite harboring place is under the floors. A properly constructed concrete floor with a foundation wall

built at least 36 to 48 inches deep will prevent such animals from burrowing under the floors and using this as a breeding place. When wooden floors are built on posts far enough from the ground so that there is light underneath, vermin will not bother much, but such floors constructed on a regular foundation must have all air holes and open spaces carefully screened. Even then it is sometimes difficult to keep vermin out.

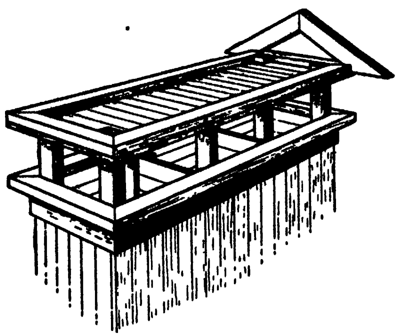


Fig. 23. The ventilator head for a three flue chimney for a three-story poultry house. (Courtesy of Agr. Eng. Dept., Cornell University.)

Sanitation. More and more poultry-keepers are coming to realize the importance of cleanliness in combating diseases. The modern poultry-house should be planned in such a way that frequent cleaning and disinfecting can be done easily and quickly. The nests, roosts and other interior

Fig. 24. A floor outtake flue in a warm poultry house. The bottom of the flue is only about a foot above the floor. (Courtesy of Agr. Eng. Dept., Cornell University.)

equipment should be built so they can be taken apart quickly, moved and cleaned. Dropping boards (Fig. 26) should be provided to keep the night droppings from the floor, while smooth cement will make the cleaning of the floors an easy task.

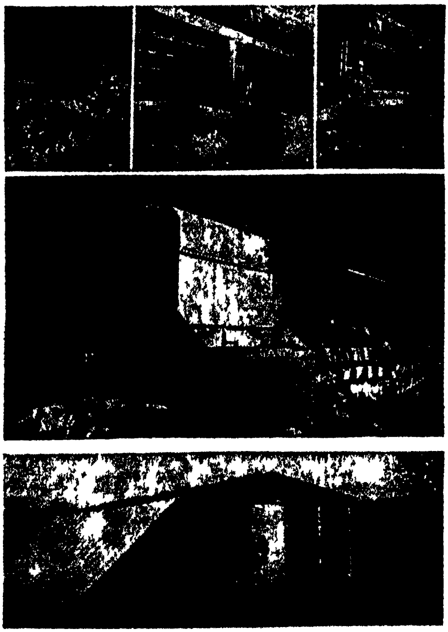


Fig. 25. Above, a carrier to save labor in a long poultry-house, center, a chart board on the carrier for the trap-nest sheets; below, a very cheaply constructed house in which one end is kept open all the year round.

Screened pits (Fig. 27) are preferred by some poultry-keepers instead of dropping boards, as they think it requires less work to clean them. (See further details on page 83,)

Temperature. A good poultry-house should afford protection against winds, storms and extremes of weather, both in summer and in winter, for hens are very sensitive to violent temperature changes and register this immediately by lower production. When the weather suddenly becomes very cold, there is a greater demand for fuel to keep up the heat of the body. At such times the food that is being used for the manufacture of eggs may be diverted to heat the body. Hens which roost in exposed places and are not sheltered from sudden changes of weather may be healthy enough, but they seldom lay well.

A recent preliminary test made by the Poultry Departmen at Cornell University showed that the egg production is no affected until three to five days after an extreme temperatur

is experienced. This experiment further demonstrated that when good ventilation is given, the combs of single-comb White Leghorns will not freeze seriously until the temperature in the

Fig. 26. The dropping board screened. Note the hinged board in front to permit cleaning.

house drops below 15° above zero. A study of the food consumption in this test also showed a marked decline in total consumption on very cold days. These three results have their

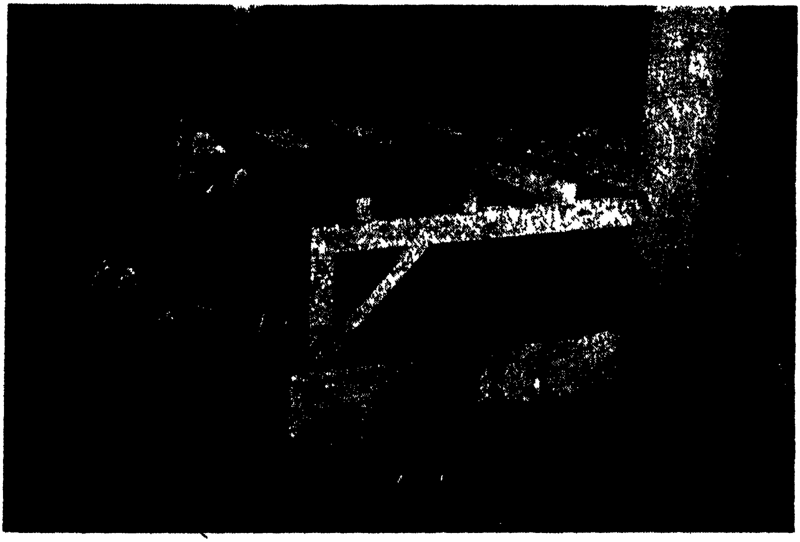


Fig. 27. A screened dropping pit.

significance for poultry-keepers. There is no question about the need for ample protection, but it must not be done at the expense of good ventilation. If the house can be well ventilated but warm enough during cold snaps so that the combs will not freeze, and extra feeds of a very palatable nature are fed to stimulate the appetites of the birds so that the total food consumption is kept from changing much, a more uniform egg production will be maintained.

A few years ago, investigators at the Kansas Agricultural Experiment Station watched the way flocks of White Leghorn and Rhode Island Red hens produced during extremes of weather throughout the year. They found that during periods of exceptionally high temperature (90° F. or more), production decreased 5 to 20 per cent, the birds consumed 12 per cent less feed, and the average size of eggs decreased 15 to 20 per cent. When the investigators placed 38 laying hens in batteries in a brooder-house and raised the temperature artificially from 76 to 92 degrees in a few hours, two of the hens died the following day, apparently from the sudden rise in temperature. It is obvious, from this, that chickens have great difficulty in adjusting themselves to such rapid changes in temperature; and the effect of such changes is a serious menace to their health as well as to egg production.

During extremely hot spells, losses from heat prostration can be reduced by spraying the ceiling and inside walls of the pen with a hose every two hours during the day. When this was done on the Cornell Experimental Farm, it reduced the temperature in one pen 13 degrees immediately.

HEAT FOR POULTRY-HOUSES

There are many conflicting opinions on the value of heat in poultry-houses. Very little practical research has been done, largely because of the cost of such work. Most of the results thus far do not show much in favor of the use of heat, especially when the extra costs of labor, equipment, installation and fuel

are taken into consideration. Recent observations indicate that as good results can be obtained through proper insulation of the building as with heat.

The writer has observed that when heat is used the litter is kept drier and does not have to be changed so often.

Size of the building. The size of the building depends on the size of the flock, the breed, and whether the birds are confined to the house or allowed free range.

The smaller the flock, the more square feet of floor space are required for each hen. A few hens do better when they have from 6 to 8 square feet each, while a flock of 150 Leghorn fowls will do very well with an allowance of 3¼ square feet each. The same number of Barred Plymouth Rocks will require 4 square feet each. This latter amount is a good average figure for all breeds in large flocks. Most practical poultry-keepers agree that it does not pay to over-crowd. This is particularly true when the birds are confined during a large part of the year.

The following table gives the capacity of different-sized buildings:

TABLE XV

HOUSING CAPACITY OF POULTRY BUILDINGS

SIZE OF BUILDING	SQUARE FEET	LEGHORNS	HEAVY BREEDS
8 x 8	64	15	12
14 x 16	224	60	50
20 x 20	400	125	100
24 x 24	576	180	144
30 x 30	900	280	225
20 x 30	600	190	150
20 x 80	1,600	500	400
20 x 160	3,200	1,000	800

The more nearly square a building is, the more economical it is to build. The deeper a house is from front to rear, the more comfortable it will be in the back part where the birds roost. Narrow long houses are the most expensive to build because they have a greater perimeter. On account of the difficulty of securing the maximum amount of sunlight without

making the building excessively high and cold, it is not advisable to build a one-story poultry-house more than 20 or 25 feet wide. Houses should not be built higher than is necessary for the convenience of the operator and good light.

MULTI-STORY HOUSES

In recent years many poultry-keepers have built multi-story houses (Fig. 28), since they occupy less ground and require much less foundation and roofing material as compared with a

Fig. 28. A multi-story poultry house. Note flue outlet on the roof and litter chute on side of the building; also built-in intakes on two sides. (Courtesy of Ray Bender.)

single-story building of equal capacity. As these are the most expensive parts to build, and as the roof is the most costly part to maintain, these savings reduce the cost per bird.

In most cases two-story houses are easier to operate than those with more floors, except when the building is located on sloping land which makes it possible to unload feed and other supplies on the second floor, or when economical means of elevating feed and other material are provided. Everything considered, it is usually more desirable to keep flocks of less

than 500 birds in a one-story building. For larger flocks the multi-story house is more economical. A barn-type building (34 to 38 ft. wide) with a gambrel roof has been built by a few. This kind of building can be used for other purposes if the operator decides to quit poultry-keeping. An elevator of at least 500 pounds capacity is needed for greatest convenience for large buildings. The flue system of ventilation is best adapted to such houses.

It is advisable in constructing multi-story houses to have the stairs in the feed-room rather than on the outside. This arrangement is more convenient in stormy weather, and less dangerous in winter when the steps may be covered with ice.

Fig. 29. A two-story shed-type poultry house.

The feed-rooms must be separated from the pens by solid board partitions to prevent drafts from the stairs. Provision should be made for unloading feed and supplies into the feed-rooms from the outside. Manure and litter from the upper floor can be passed to a manure wagon or manure sheds by means of chutes through the floor or the side walls.

Figure 29 shows a two-story house which has been in operation for four years. Since the original house was built, the owner has been sufficiently satisfied to add two similar sections.

REMODELED BUILDINGS

Barns, sheds and many other kinds of buildings may be made over into first-class poultry-houses with a definite saving as compared with new construction. Usually the flue method of ventilation works best in remodeled buildings.

BUILDING MATERIALS FOR POULTRY-HOUSES

Wood makes the best material for poultry-houses because it is a poor conductor of heat and cold and does not gather dampness. It is the most common material employed and is usually the cheapest. Well-seasoned lumber is advisable even if it costs more, as unseasoned lumber is likely to shrink, leaving many cracks.

Concrete-block, concrete, brick, and tile houses may be built in sections where these materials are cheaper than wood, but it is well to remember that they are less desirable, as they are good conductors of heat and cold, and moist air condenses more freely on them in cold weather unless there is good ventilation at all times.

Mixing concrete. Concrete is a mixture of cement with sand and gravel or crushed stone. A 1-3-5 mixture means 1 part of cement, 3 parts of sand, and 5 parts by volume of gravel or crushed stone. When gravel is used, this means that the sand has been screened from the gravel. Sometimes the concrete is made by mixing 1 part of cement to 5 parts of sand and gravel as it comes from the pit, but the gravel under these conditions usually has too much sand. It is best to screen the sand from the gravel and mix it with the cement in exactly the proper proportions.

If much concrete is to be mixed, it is easier, faster, and better to hire a mechanical mixer for the job.

The usual method of mixing concrete by hand is to measure the sand and gravel by means of a mixing box without a bottom. A bag of cement is considered equal to one cubic foot.

The cement, sand, and gravel or stone, are mixed dry and very thoroughly until the color of the pile shows that the cement is evenly distributed through the mixture. This takes not less than three shovelings. The mixture is then spread out, leaving a large hole in the center. Water is then poured into this hole. It is again mixed very thoroughly until all the concrete is of the same color and consistency. For foundation and floor work, too much water should not be added. The mixture should be able to stand up in a steep conical pile without sliding down and without extra water running away from the base. Too much water weakens the concrete.

After the first twenty-four hours the surface of the concrete should be wet down twice a day for at least ten days. If these directions are followed, the concrete will be well cured and strong.

TYPES OF ROOFS

The shed roof is the one most commonly used and recommended. It requires the least amount of material, is easy to construct, turns all the water to the rear, and provides a relatively small amount of cubical air space within the building. Shed-type houses are very easy to ventilate, but should not be built wider than 20 or 25 feet because of the difficulty of securing plenty of light without making the building excessively high in front.

The combination roof consists of one long and one short roof and is a modification of the shed roof but more attractive. This roof is adapted to buildings 20 feet wide or more. The combination roof, although it cuts down the cubical air space even more than does the shed roof, is not so easy to ventilate because the warm air is pocketed at the high point, unless cupolas or ventilators are provided. Furthermore, it prevents the direct sunlight from striking as far back in the house as is the case with the shed or half-monitor types.

The gable roof is probably the oldest type used on poultry-

houses. This type of roof is commonly used on buildings over 25 feet in width and one or more stories in height. A ceiling reduces the cubical air space and makes them warmer. The flue system of ventilation is best adapted to buildings with a gable roof. Sometimes to save expense a straw loft may be used.

A good straw loft is made by placing poles from plate to plate across a building and covering them with loose boards or two-inch mesh chicken-wire fencing to support the straw and keep it in place. Two or three feet of straw is then spread over this support and a window or a door is cut in each gable just above the top level of the straw. The warm moist air from the room below will slowly filter through the straw and be carried out of doors by the circulation through the building above the straw, leaving the pens dry and comfortable. This is a very satisfactory and cheap method of ventilating a poultry-house, because the air is rapidly changed without drafts or making the pens unnecessarily cold.

A straw loft is especially well adapted for localities in which there are rapid changes of weather and extreme cold temperatures, because it gives the building added insulation. For this reason, a building with a straw loft is cool in summer and warmer in winter. Its main disadvantages are that it is dusty and a good hiding place for vermin. Straw lofts are often used in remodeling barns or other outbuildings.

A gambrel roof is similar in type to the gable; the difference being that it has two slopes instead of one. Single-story houses with this roof may be built without sides (Fig. 25). The end of such a building should face south and a straw loft may be used. Such a building is very cheaply constructed, is fairly light, and is comfortable. It is especially adapted to square buildings. A house 30 x 30 or 30 x 40 feet is commonly built with this roof.

The half-monitor roof is very popular in some sections and is probably the most attractive in appearance. It is particularly

adapted to houses 25 feet wide or more and is often used in remodeling old houses that are too narrow and high. This type of roof is expensive to construct and makes the building drafty and cold when the windows at the peak are opened to give proper ventilation. The cubical air space is also greater, especially if the front slope of the roof is built high enough to prevent the caretaker from bumping his head. On account of their width, very long buildings with such a roof are more difficult to clean.

The monitor roof is a relic of the past. It is not practical in constructing a modern poultry-house.

ROOFING MATERIAL

Prepared roofing materials are usually the most satisfactory coverings for poultry-houses. They are generally cheaper, more quickly and easily put on and repaired, and fairly durable. Shingles of good quality are more durable on steep roofs, but poultry-house roofs are generally so flat that shingles soon rot out. When roll roofing material is used, it is always best to lay it on a smooth tight surface of matched lumber. This makes it easier to lay, adds to its durability, and, most important of all, prevents the wind from lifting it. In very windy locations it is advisable to use cleats on top of the roofing material to hold it down.

Built-up roofing is made by laying several thicknesses of roofer's felt and melted asphalt over wood sheathing on the roof. The first layer is nailed down, but each succeeding layer is cemented down with hot asphalt. Built-up roofs are usually 3 to 5 courses in thickness and make a durable covering for roofs which are almost flat or with ½ to ¾ inch rise to a foot. This type of roofing requires special equipment and experience in applying. Also the proper grade of asphalt should be used.

Metal roofing is undesirable. It is a good conductor of heat and cold, which tends to make the building hot in summer and cold in winter and subject to the condensation of moisture.

Slate is similar to metal roofing and is still further objectionable because of its weight.

THE SIDE WALLS

The walls of poultry-houses should be of tight construction for protection against storms and to prevent drafts.

Under ordinary climatic conditions where the temperature does not go much below zero, or heat is used, one thickness of tight ⅞-inch lumber is sufficient. In colder climates, or when it is desired to prevent freezing, or heat is used, insulation should be considered. Good insulation need not be too expensive.

Roofing material or building paper should never be put on the inside between the siding and studding, as it is likely to get torn and makes a harboring place for mites.

INSULATED SIDE WALLS

One of the most popular and satisfactory ways to insulate a building is to use any good, reasonably tight siding on the outside, and sheathing over waterproof building paper on the inside of the studs, with shavings packed in between. Dry, thin, pine shavings, packed tightly to prevent settling, are most satisfactory. A bale of shavings will fill 40 to 50 square feet of wall space. Rock wool has a higher insulating value but costs much more. Any insulating material should be thoroughly dry when installed, and about one-half pound of dry hydrated lime should be mixed with each bushel of shavings or similar material to discourage vermin from working in it. The lime also tends to prevent the development of wood-destroying fungi.

Insulated walls should have a vapor barrier between the insulating material and the warm side of the wall. Paper between the insulating material and the outer siding is seldom to be recommended.

There is considerable variation in the passage of heat or

cold through different building materials. Usually, materials of large bulk and light weight have high heat resistance and are better thermal insulators than the more compact and heavier ones. Dead air spaces do not provide very satisfactory insulation unless the spaces are small enough to prevent the circulation of air within them. Only spaces that are air-tight are valuable for thermal insulation. The insulating value of an air space can be greatly increased by filling it with insulating material.

Table 3 [2] in the appendix lists the relative insulation values of different materials taken from accepted standards.

Although certain types of insulation board have very good insulation value, chickens will pick holes in them; consequently they should not be used where chickens can have access to them. Such materials warp easily unless properly nailed and well supported.

INSULATED CEILINGS

Roof or ceiling insulation is most important since the heat loss is greatest through the roof. The best arrangement is to have an air space between the roof and the insulated ceiling, with an outside opening so that air can circulate between the roof and the ceiling. Insulating the roof is not so satisfactory because of the danger that roof leaks may wet the insulating material. Ceiling insulation under these conditions will greatly affect the temperature of the pens below, both in winter and in summer.

Well-insulated ceilings may be constructed effectively and inexpensively by spreading paper over cheap lumber. From 6 to 10 inches of cut straw, chaff, shredded corn stalks, or dry leaves should be placed over the paper. Vermin will be discouraged from working in this material by mixing one-half pound of hydrated lime with each bushel of insulating material.

[2] Prepared by Prof. A. M. Goodman, Agricultural Engineering Department, Cornell University.

WINDOWS, PARTITIONS, AND DOORS

The purpose of windows in a poultry-house is to admit light and provide ventilation. In the northern part of the United States, about 1 square foot of glass window space is allowed for every 16 to 20 square feet of floor space.

Glass windows may be double, one sash above the other.

Muslin-covered windows are not being used in the newer houses where there is a good system of ventilation. Windows that are to be opened and closed should be arranged to slide up and down in their frames so that they can be easily opened and the lower sash used as a ventilator inlet if necessary.

Windows hinged at the bottom and arranged to tip in at the top, or hinged at the top and arranged to tilt in at the bottom, are objectionable, since they tend to create drafts on the floor or over the perches.

Window sashes should be so installed that they can be readily removed for cross-ventilation in summer.

Stock-sized window-sashes are the cheapest. Those with relatively small panes of glass should be selected, as they are not broken as easily as big ones and cost less to replace.

Glass substitutes, although they allow a part of the violet rays of the sun to pass through them when new, are not very durable and have little to recommend them over glass.

Glass windows should be covered on the inside with one-inch-mesh chicken-wire fencing, to prevent the fowls from flying out, and sparrows and owls from coming in, when the windows are open.

Glass windows are recommended in the rear of a house to give a better distribution of light under the dropping board.

In small houses (not over 30 or 40 feet long) the partitions should be tightly boarded from the floor to a point 30 inches above it. The remainder of the partition may be made of two-inch-mesh chicken-wire fencing, except between the roosts of different pens where boards should continue to the roof to

prevent drafts while the birds are roosting. A solid partition along the floor stops fighting between pens. In a windy location, frequent solid partitions may be necessary to cut down lengthwise drafts.

Doors should be located where they are most convenient, and should be wide enough to admit an ordinary shipping crate easily. Double-action hinges on doors between pens are desirable. The bottom of such doors should be at least 8 inches above the floor to prevent the litter from interfering with their opening and closing. A base-board keeps the hens from passing from one pen to another.

Alleyways take up valuable space and increase the cost of a building, and are therefore not needed in a modern poultry-house.

THE FOUNDATION AND FLOOR

Foundations are necessary under permanent buildings to prevent heaving by frost, to support the building, and to keep out vermin, water, and cold air. Concrete, stones, concrete blocks, brick, or posts may be used for this purpose. Concrete or stones laid in cement are the best, although posts are often employed even though they are less durable, probably because they are cheaper. In many sections concrete will prove the easiest and best foundation.

There are three general types of poultry-house floors now in use: dirt, board, and concrete. Each has certain advantages and disadvantages.

Dirt floors are the cheapest and most common. They are difficult to clean, unsanitary, and dusty, while vermin and water have free access to them. When dirt floors are used, from 4 to 6 inches of the top surface should be removed at least once during the year and replaced with clean sand or gravel. The surface of such floors should be several inches higher than the surrounding ground, to keep out water.

When gravel is expensive and difficult to obtain, a double

board floor with paper between and well supported makes a warm, dry, satisfactory floor. Screened ventilators should be placed in the foundation walls to keep the floor from rotting and to prevent rats, mice and other animals from entering.

Concrete floors are durable, rat-proof, sanitary, easy to clean, dry and economical. A concrete floor must be built carefully to meet these conditions (see page 81).

VI. A House for Laying Hens

SUMMER is the best time of the year to build a poultry-house. If the floor is made of cement, it has plenty of time to cure and dry out before the stock is housed in the fall.

THE FOUNDATION AND FLOOR

The first step after choosing the location is to mark off the ground and determine the level of the floor. This is done as indicated in Fig. 30, as follows: Locate the corner of the building D at the highest point on the site, and around this drive three stakes about 3 feet apart, A, B, C. By means of the spirit level and a straight edge, determine the level of the floor X 6 inches above the ground at the corner D and mark this level

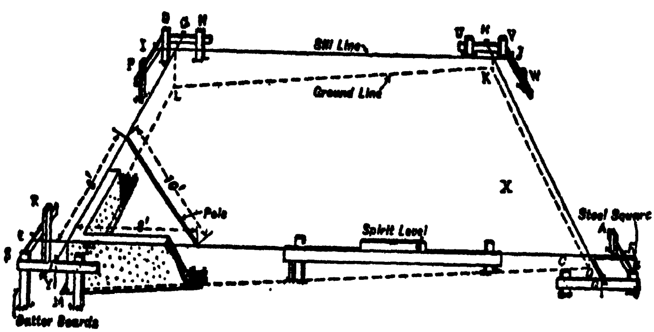


Fig. 30. Laying out the foundation.

on each of the stakes A, B, and C. Connect these stakes with boards, with the top edge even with these marks. Run a line, G-H, over the point D, which will be the direction of the front of the building, and in the same way another line F-E at right angles with G-H will represent one side. Measure off on these lines the length and breadth of the house from the point D. Drive stakes around corners M and K similar to D. Determine

the level of the corners, M and K by means of the spirit level and straight edge from the point D, marking the level on the stakes U-V-W and R-S-T. Nail boards to these stakes so that the top edges are even with the marks. Level lines can then be run between the points G-H and F-E. In a similar way the position and level of the corner L can be found from the points M or K, and the lines Y-Q and J-I can be located. The position

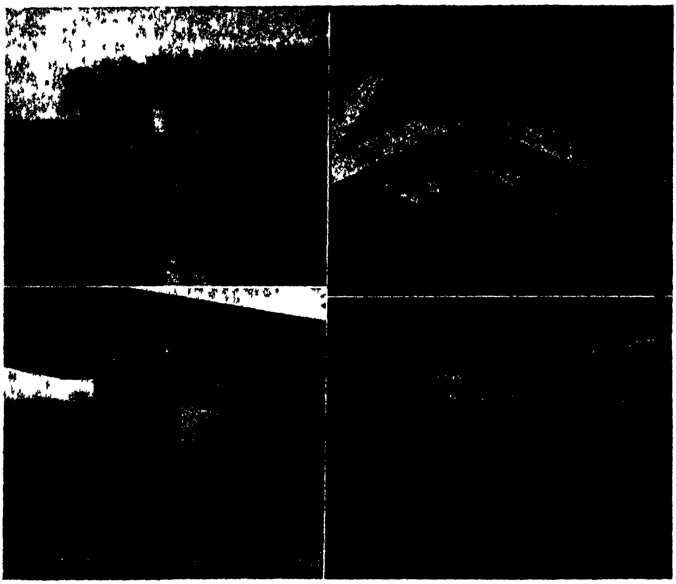


Fig. 31. Above: left, digging the trenches for the foundation wall; right, the sills bolted in place. Below: right, construction of the rafter and plate on rear of house; left, construction of rafter and plate on front of house.

and width of the foundation walls can be found by running lines parallel with G-H, F-E, Y-Q, and J-I.

The corners can be made absolutely square by using the 6-8-10 method. This is done by measuring off 6 feet in one direction and 8 feet in the other. When the distance between the two points is 10 feet the angle is a true right angle.

The trenches for the foundation should be made a few

inches wider than the thickness of wall to be built, and deep enough to be below the frost line (Fig. 31). Usually 3 to 4 feet is sufficient. If the soil is heavy or moist, a three-inch tile can be laid in the bottom of the trench, arranged so that the water will run off at the lowest point. The trenches can then be filled to within one foot of the surface of the ground with stones or cinders tamped down solidly. This provides a good base on which to lay a stone, concrete-block, brick, or concrete foundation wall.

If concrete is to be used, the forms can be placed on the base already mentioned, being sure that they are perpendicular with the lines indicating the position of the foundation walls and level with them at the top.

Ordinarily a wall 6 to 10 inches thick is strong enough for most one-story poultry-houses. For two- and three-story houses 12 to 18 inches is recommended. If a 6-inch wall is to be constructed the forms must be 6 inches apart when in place. The forms should be braced securely at the bottom with stakes, and pieces nailed across the top every 3 feet to prevent them from spreading after pouring in the concrete. The corners should also be nailed carefully to prevent bulging.

After the forms are filled to the top and before the concrete has a chance to harden, ½ x 10 to 14-inch threaded rods should be placed in the concrete every 10 to 12 feet, with the threaded ends protruding about 3 or 4 inches above the top surface of the wall. The bolts hold the sills in place after the wall has properly hardened.

Concrete should not dry out too quickly; consequently it is better not to remove the forms for a few days, as they help to retain the moisture.

LAYING A CONCRETE FLOOR

A 1-2-4 concrete mixture is recommended for foundation walls. The total amounts of materials required for such a wall may be estimated as follows:

Number of cubic feet in wall x 0.222 = sacks of cement.
Number of cubic feet in wall x 0.017 = cubic yards of sand.
Number of cubic feet in wall x 0.034 = cubic yards of stone or gravel.

A 1-2-3 concrete mixture is recommended for the floor. Materials needed are estimated as follows:

Square feet of floor area x 0.0650 = sacks of cement.
Square feet of floor area x 0.0050 = cubic yards of sand.
Square feet of floor area x 0.0072 = cubic yards of stone or gravel.

Directions to construct a concrete floor are as follows: Fill the space inside the foundation walls to within 3 inches of the level desired, with stones, soft-coal cinders, or gravel, and see that it is tamped or rolled down solidly and smoothly. Over this, put a layer of tar building paper with the edges cemented with hot tar, to prevent capillary attraction of moisture by the concrete from the earth below. Then lay a three-inch layer of concrete of a 1-2-3 mixture, and cover this immediately with a thin surface coat of 1 part of cement to 1½ parts of screened sand. Use a straight edge and spirit level to get a firm level surface before troweling in and smoothing off the top coat. The floor should be properly cured before it is used. Usually this takes about two weeks.

INTERIOR FIXTURES

The interior arrangement of a house is of great importance, because the ease and rapidity of caring for the birds, as well as their comfort, depends on it.

Perches. In most poultry-houses, especially of the shed type, the perches are placed in the rear of the building (Fig. 32). By this arrangement, the light on the floor is not seriously affected when dropping boards are used. They are out of the way of the poultry-keeper and are better protected against drafts from the open front.

Straight peeled poles about 2 or 3 inches in diameter, or 2

by 3 or 2 by 4-inch lumber with the corners rounded off, can be used for perches. They are usually set 12 or 15 inches apart, in 2 by 4-inch cross pieces which may be suspended from the rafters by small chains or heavy wire. All the perches should be on the same level, 8 inches above the dropping board, and the last one at least 9 inches from the rear wall. Birds of the

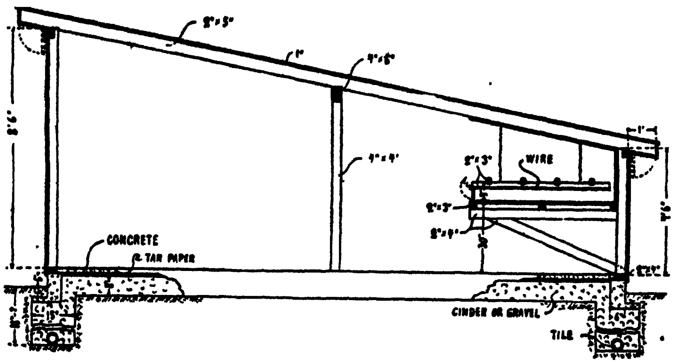


Fig. 32. Cross-section through the center of a Cornell laying house 20 x 20.

Mediterranean class, such as the Leghorn, require 6 to 7 inches of roosting space; heavier breeds need 8 to 9 inches.

The dropping boards and pits. Dropping boards keep the floor cleaner by catching the night manure. They should be made in sections, with the ends of the boards at right angles with the rear wall so that the cracks will not interfere with cleaning. The dropping boards should be located 2 to 2½ feet above the floor and extend from the rear wall to a point at least 7 inches beyond the outer perch. It is desirable to screen the dropping boards. To do this, a 16-gauge 1½-inch-mesh wire, or a square-mesh welded wire 1 x 2 inches, 14-gauge, should be fastened to the under side of the perches. A hinged board in front permits cleaning but keeps the hens away from the droppings (Fig. 26).

Many poultry-keepers are replacing dropping boards with dropping pits (Fig. 27). These should be about 18 inches deep,

have the same area of floor space as the dropping boards, and be screened. The roost frame (with screen attached) may be used as a cover for the pits. One side of the frame may be

Fig. 33. Front view of the Cornell laying house. Note the ventilator boards hinged to the projecting rafters. They should be one inch narrower than the opening. These boards may be closed or lowered by means of a cord and pulley from the inside.

attached to the side of the pen and the other rest on the front edge of the 18-inch frame, so that the roost frame can be easily lifted when the pits are cleaned.

The advantages of the pits as compared with dropping boards are: (1) they cost less; (2) they eliminate daily cleaning of the dropping boards; (3) there may be less foot and internal injuries because of lower perches.

The disadvantages are: (1) they occupy floor space which might otherwise be used by the birds; (2) accumulations of droppings are heavy and may require special supports if other than the ground floor is used; (3) unless properly protected, wood floors will rot out in time; (4) the accumulated droppings give off objectionable odors and moisture.

Nests. Nests should be so constructed that they can be moved, cleaned, and reached easily by the caretaker. One nest is required for every five or six hens. The number needed depends largely on the rate the hens are laying. Leghorns and like breeds should have a nest 12 inches square; but for the

heavier breeds, like New Hampshires, one 12 by 14 inches is better.

Nests are often built under the front edge of the dropping board, and so arranged that the hens enter from the rear while

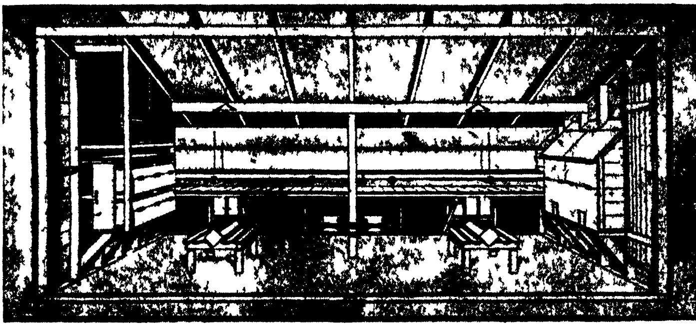


Fig. 34. Interior view of Cornell laying house, showing the arrangement of the equipment.

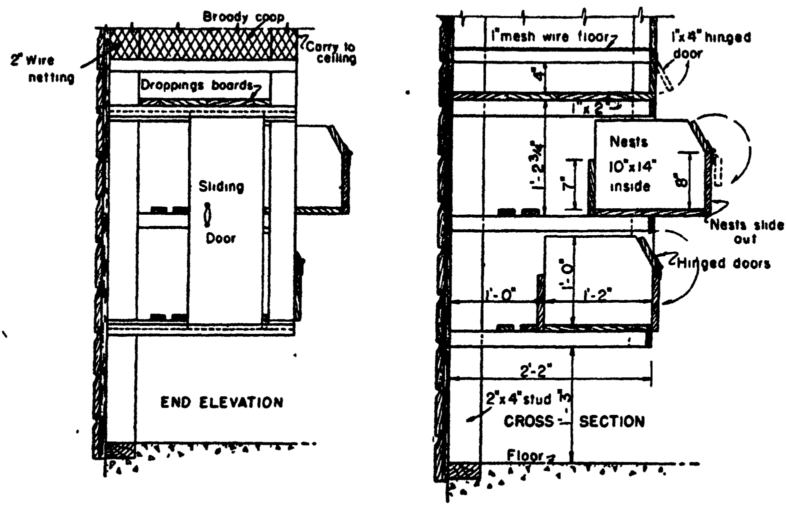
the eggs are gathered through a door in the front. It costs less to build nests in this location, but they interfere with the catching of birds and cleaning, and have the further disadvantage of shutting off the light on the floor under the dropping board unless there are windows in the rear wall. It is also difficult to close the nests at night to prevent birds from roosting on the nests.

The nests should be not less than 7 inches deep so that a good body of nest material can be retained. Repeated tests on the Cornell Experimental Farm show that white pine shavings, or similar fine material, make the best nest material. Where shallow nests were used with scanty nest material over the bottom, 50 per cent more broken and soiled eggs were observed.

The best arrangement is to have the nests on the side walls or partitions (Fig. 34). They should be made in movable sections of four or five nests each for ease in cleaning, and arranged so that the hens enter from a runway in the rear. The eggs can be gathered through doors in the front. A steep hood

of boards over the top, and sliding doors on the ends, will prevent the hens from roosting on the nests at night.

Trap-nests. A trap-nest for poultry is so constructed that a hen automatically traps herself, while entering to lay. After



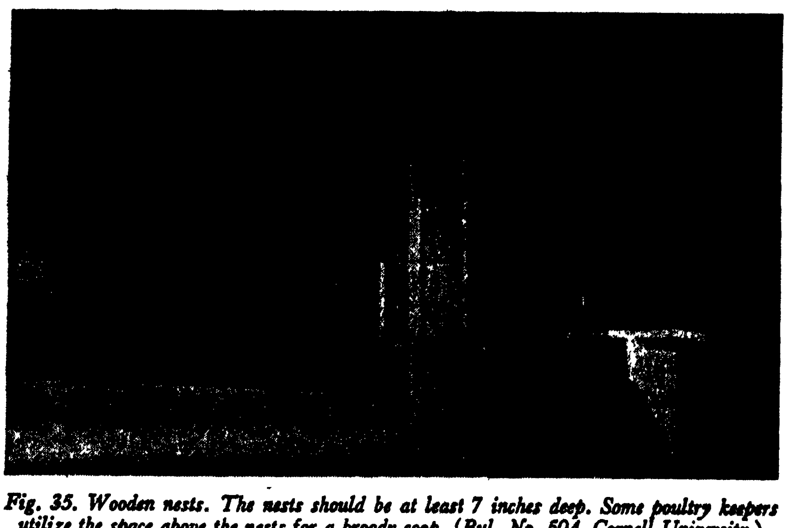


Fig. 35. Wooden nests. The nests should be at least 7 inches deep. Some poultry keepers utilize the space above the nests for a broody coop. (Bul. No. 504, Cornell University.)

laying, the bird remains in the nest until released by the attendant. Trap-nesting demands close attention, for the caretaker must make the rounds of the nests several times during the day so that the hens will not suffer from confinement after they have laid and the nests will be available for other birds. A flock of thirty hens will need six or seven trap-nests.

The essential points of a good trap-nest are as follows:

(1) It should be accurate, *i.e.*, it should prevent two hens from occupying one nest at the same time or certain birds from entering and leaving without being caught, (2) it should be easy and quick to operate, (3) it should be easily and cheaply constructed, (4) it should provide sufficient ventilation in warm weather to prevent birds from suffocating, (5) it should be easy to clean, (6) it should prevent birds from injuring themselves.

The broody coop. Every small poultry-house and each compartment in a long laying-house should have its own broody coop. The broody coop can also be used for extra males or sick hens, or it makes a handy place to confine rejected hens while culling.

It may be advisable in a warm climate to have the broody coop outside the house in a shady place, but ordinarily for convenience it should be located in the house near the nests. All broody coops should have slated or wire bottoms. With this arrangement the coop is kept sanitary and the circulation of air through the bottom is an important factor in breaking up broodiness. Provision should be made for feed and water in each coop.

When the nests are against the side walls, the broody coop can be built above them. In this case, the side wall and roof make two sides, while the floor underneath the bottom of the broody coop makes the top cover of the nests. A large broody coop with more than one section can be made when it is so located, but if there is more than one tier of nests the coop is so high that it is unhandy.

An extra high shipping crate, with a slated or wire bottom and a specially constructed door on the side, can be used as a broody coop. This kind of coop can be hung on hooks or small chains under the dropping board.

Feeders. A good mash-feeder (Fig. 36) is a very important part of the poultry-house equipment because the egg production depends to a large extent on the proper intake of mash.

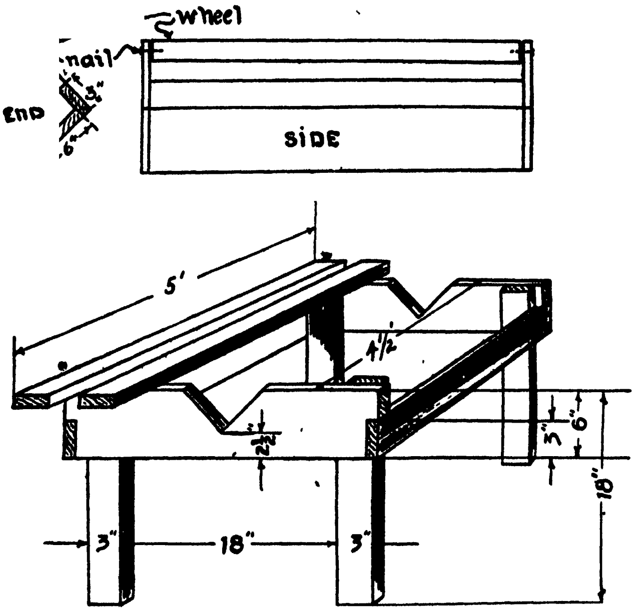


Fig. 36. Detail of Cornell dry mash-feeder.

Trough-feeders increase the mash consumption by maintaining a constant easily accessible supply, and prevent waste when they are not filled more than half full. One foot of double feeding space is allowed for every ten hens. When trough-feeders are used in a large poultry-house, it is more convenient to have storage-bins in every pen.

Grit and oyster-shell can be supplied to small flocks by means of small metal or wooden hoppers hung on nails on the

side wall. For large flocks, shallow open boxes on a platform near the trough-mash-feeders are the best.

Watering dishes and stands. Water may be supplied in pans, pails or troughs. Twelve-quart pails set in racks are the handiest and cheapest. One pail should be provided for every fifty hens. Troughs are often used where running water is available. They should be built stationary, with one end a little

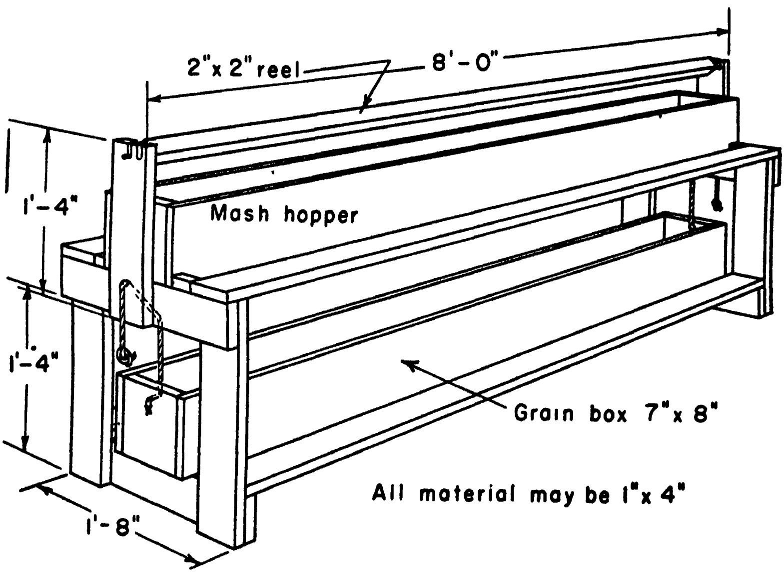


Fig. 37. Cornell combination grain and mash trough. This feeder is designed especially to meet the needs of those who trough-feed grain entirely or partially. The combination of mash above and grain below provides feeding space with equipment which occupies a minimum of floor space. If one does not want to trough-feed grain, both troughs may be used for mash; this reduces the amount of floor space for mash feeding.

When grain is to be fed, the lower trough is dropped by releasing the knotted end of the rope from the slot as shown. At other times the trough is held up against the bottom of the upper trough. (Bul. No. 504, Cornell University.)

higher than the other and a hole at the lowest point, with a drain-pipe and plug for cleaning. All watering dishes should be elevated at least one foot above the floor to prevent dirt and litter from being scratched into them.

A pan, a half-barrel, or a metal washtub under the platform

which carries the waterer, will catch the water spilled by the birds while drinking. The least amount of water will be spilled when the water level is about the same as the platform where the birds stand. Attention to this point will help greatly in preventing damp litter.

WATER SYSTEMS

The minimum daily requirement of water for 100 Leghorn hens is probably 10 quarts, while the maximum amount for a laying flock will vary from 23 to 25 quarts. Of course the amount of water used by hens varies with the rate of laying, temperature of the air, temperature of the water, dry-mash consumption, and amount of green feed or wet mash fed. Fowls normally drink twice as much water in proportion to their body weight as do cattle, sheep and swine. Supplying water to chickens requires more labor than any other detail in caring for a flock. Running water with automatic control, therefore, is the most important labor-saving device in a poultry-house.

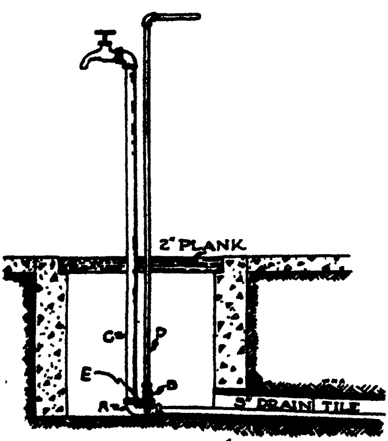


Fig. 38. Running water in the poultry house. The non-freezing hydrant used to drain pipes to prevent freezing. A, *Stop-and-waste valve;* B, *Fitting for extension handle;* C, *Riser pipe;* D, *Extension handle;* E, *Drain hole valve.*

Provision for a water system should be made before the floor is put in. For a large house the pipe should be at least 1 inch if of galvanized iron, and ¾ inch if brass or copper tubing is used. Outside, the pipe shoud be 4 feet below the surface. Under the house, the pipe is safe from frost a foot below the floor.

Fig. 38 shows an easy and safe way to provide running water in a pen.

The important points about a good watering device can be summarized as follows:

1. The container should be easy to remove and clean.
2. There should be a guard over the container to keep the birds from contaminating the water.
3. Some means of catching the drip from the birds' beaks and wattles should be provided. This keeps the litter dry.
4. A constant and adequate supply is necessary at all times.

A trough waterer with an automatic float is another way of supplying running water. This should have a tall wire guard to keep the birds from soiling the water and to prevent interference with the float. Such a trough can often be installed

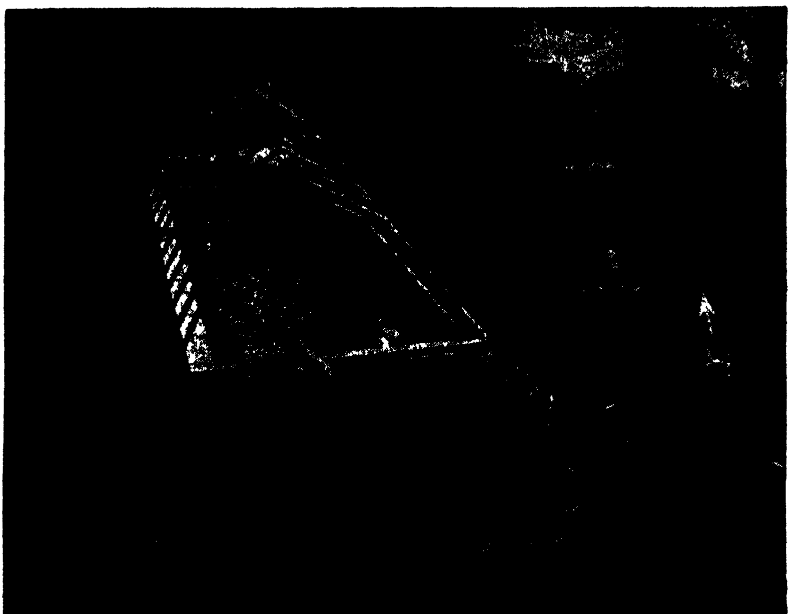


Fig. 39. A continuous flow waterer. The photograph shows a simple arrangement for supplying running water through float-valve fountains in cold weather. After the water is turned off at F *the water in the pipe drains away in the ground. By opening valve* H *and removing plug* A *the trough and the pipe are drained.* C *is a ball float.* D *is an automatic valve.*

through a partition to furnish water for birds in two pens. This reduces the cost of watering equipment such as trough, supply pipe, drain, and heating unit, by using it for a large number of birds. The supply pipe must be protected from freezing by the use of insulation or by draining with a stop and waste valve as in Fig. 39.

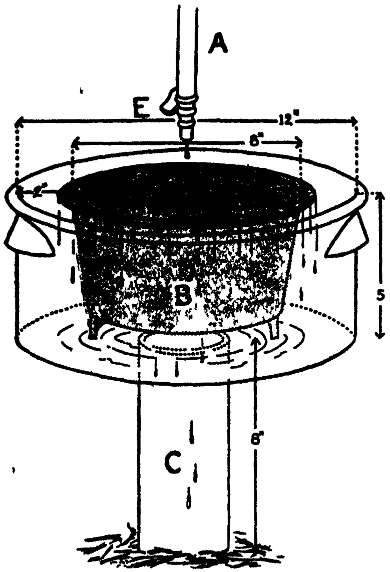


Fig. 40. A continuous flow waterer. Water is supplied by pipe A; E *is a pet cock for adjusting the flow of water;* B *is a removable pan on legs.* C *is the tile drainaway. When the pan* B *overflows the water drains down the pipe* C.

The water supply and drain pipes pass from the bottom of the trough through an insulated heated box underneath the trough.

Still another method of providing a continuous flow of fresh water is shown in Fig. 40. This system is practical when plenty of spring water is available by gravity. The water trickles slowly through the adjusted valve attached to the lower end of the suspended supply pipe, into the inner small pan. It then overflows into the larger pan and runs down the drain pipe soldered to the bottom.

Two important sanitary measures are offered by this waterer. The inner pan stands on legs, which permits the water overflowing from it to run out unobstructed through the drain pipe in the larger pan. The fact that the inner pan is removable makes it easy to clean.

The space between the rims of the two pans, about two inches, catches the drip from the beaks of the birds and thus keeps the floor dry around the waterer.

A platform of heavy wire, supported by metal or wood,

should surround the pan at the water level. Sometimes a 12-inch tile is used under the pan as a drainway.

Carriers. In large poultry-houses a carrier suspended from a track on the rafters will reduce the labor and make the work of caring for hens much easier. However, such equipment is expensive and should not be considered in small houses where the invèstment would be excessive for the number of hens involved.

LITTER CHUTE

A well-planned litter chute is a good labor-saver in a multistory poultry-house. A chute 24 x 36 inches in cross-section, and arranged at the bottom to discharge into a manure spreader or wagon, is recommended.

THE FEED-ROOM

Most poultry-houses of any size will need a separate room for the storage of feed, egg-crates, shipping coops and the small tools used about the building. If the feed is mixed at home, it may be necessary to have a floor large enough for this purpose. In buildings less than 100 feet long, it is cheaper and easier to board off one end as a feed-room. For convenience, this should be the end nearest the other farm buildings or the caretaker's home. Buildings longer than 100 feet should have the feed-room in the center. In very large poultry plants the feed-room should be two stories high and have a cellar as an egg-cooling room. Space will be needed not only for storing feed, but for cleaning, candling, packing and shipping eggs and dressing poultry. It is well to have the work-room of ample size and readily accessible.

LAYING BATTERIES

One of the developments of battery brooding is the use of batteries for laying hens. Each hen has an individual compartment.

The compartments are about 16 inches wide, 18 inches long, and 18 inches high. The system is well adapted to localities in or near our larger towns and cities where land valuations or zoning regulations make the usual plant impractical. In such locations it is possible also to utilize empty factories or other buildings at moderate rentals for such purposes. Laying batteries have not been accepted generally by experienced poultry-keepers, largely because of the increased cost which increases the investment per bird.

Design and construction. In selecting laying batteries, attention should be given first to the cost per bird, the durability and construction of equipment, possible upkeep and repairs, ease of taking apart to clean and disinfect, ease and completeness in removal of droppings, cost for renewal of belt or paper used for droppings, construction and ease of cleaning of waterers and feeders, construction of wire floors to reduce destruction by rusting and injury to the feet of the birds to a minimum, construction of egg trays to prevent breaking and soiling of eggs, and, finally, construction of any sort which might lead to injury of the birds in any way.

Building. After selecting the cages, the next step is to find a suitable building or room for them. Good housing does not necessarily mean expensive buildings, although, where running water is provided, the room temperature must be kept above freezing, and a well-constructed building carefully insulated helps to reduce the amount of artificial heat necessary in cold weather.

Room temperature. The best room temperature is not known, but during the winter probably 40° to 60° F. is satisfactory; in summer the room should be as cool as possible, and provision should be made against too high temperatures which may occur from the animal heat of the birds and faulty construction of the building.

Ventilation. The problem of ventilation is very important with a large number of birds in a restricted area; forced venti-

lation is usually necessary. This is not so important when there is a small installation. Without question, uniformity of temperature is essential both in winter and in summer, and extremes of temperature reduce production. Oftentimes the crowded condition of a battery room makes summer ventilation a problem.

There are substantial buildings on many farms that can be remodeled into satisfactory places for laying batteries at a reasonable outlay; but when new buildings are required, a better building than the ordinary is necessary. Under such conditions it is wise to consult the battery manufacturers as to specific room requirements for their types of cages, the best method of ventilation, and the proper arrangement of the batteries to utilize labor to the best advantage.

Ordinarily about one-third less than the usual floor space is required to accommodate a given number of layers in batteries. The extra cost of the batteries, insulation, heating equipment, fuel, ventilation and depreciation must be charges against the saving in space. When all these costs are considered, the saving due to increased capacity may disappear.

Keep cells filled with good birds. The quality of birds used in laying batteries is important. They must not only be healthy and relatively free from disease, but be bred for the production of large numbers of market-size eggs.

High mortality, and removal of many birds because of poor laying, have an important bearing on the successful use of laying batteries. Every empty cell represents a loss of eggs and overhead expense unless a new bird can be found immediately to occupy it. Instead of eggs per hen, it is now a matter of eggs per cage. At the Ohio Experiment Station, where records were kept on this, it was found that the eggs produced per cage yearly, when replacements were made promptly, were 206. The production per cage without replacements was 141. The total replacements for the year amounted to 63 per cent; of which 42 per cent were culls and 21 per cent were dead

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birds. It is obvious, from the above figures, that the successful operation of laying batteries necessitates a continuous supply of pullets for prompt replacements. This problem is one which every poultry-keeper contemplating the installation of batteries on a large scale must consider seriously.

Good management necessary. It was first supposed that batteries would make unnecessary much of the care and skill in feeding and management required for layers in floor pens. Experience has shown that layers in batteries require even greater skill in feeding than do floor layers. Good management requires that the birds be given frequent attention and individual observation. This may seem a simple, easy procedure, but in actual practice few will be able to meet the requirements of time, persistence, and patience needed. An indifferent and careless person will have less success with cages than with floor management of layers.

The reduction in mortality has been featured by some battery enthusiasts, but this has not been borne out in every instance by the evidence available. In most cases, it is a vain hope to expect a significant reduction in mortality by the installation of this equipment. The mortality problem is more than a matter of change of environment and sanitation. It must be attacked from the standpoint of breeding, brooding, rearing, feeding, and management.

There is no doubt that batteries will eliminate cannibalism, which has been and is an important source of loss on poultry plants.

One of the things which the experiment stations have learned about feeding hens in batteries is that the rations and formulas are essentially the same as for floor layers. It was thought, when batteries were new, that considerably different rations would be necessary.

The present status of laying batteries can be summarized as follows:

1. Equal or better egg production with equal or less mortality can generally be expected from layers properly fed and managed in batteries.
2. Feed consumption is about the same, or somewhat less, than for layers in floor pens.
3. Both Leghorns and heavier breeds respond favorably in laying batteries.
4. Nutrition requirements for layers in batteries are much the same as for those in floor pens, except for vitamin-D and fiber requirements, which are generally greater for layers in batteries.
5. Labor requirements for feeding and watering layers in batteries are considerably greater than for floor pens equipped with labor-saving equipment.
6. About one-third less floor space is required for layers in batteries.
7. Effective culling is one of the greatest advantages of laying batteries.
8. Greater skill and care in feeding are required for layers in batteries.
9. The battery operator to be successful must be more alert as a caretaker and as a business man than his competitor who manages hens under floor conditions.

VII. Hatching the Eggs

NO PHASE of poultry-keeping in the United States has undergone greater changes in the last thirty years than the process of incubation. At no very distant date, each farmer hatched the desired number of chickens each year with hens. Gradually, small incubators heated by oil lamps came into use and, to a large extent, took the place of the natural method. The small incubators were quickly followed by larger ones holding thousands of eggs at a single setting. This latter development of the incubator has resulted in revolutionary changes in the production of chicks. Instead of the farmer and poultryman hatching chicks from his own stock, this matter is rapidly being turned over to hatcheries, which make it their business either to hatch the eggs of the producers for them (custom hatching) or to supply them with chicks which they hatch from eggs purchased from several breeders in the community. This centralization of the hatching, although it relieves the poultry-keeper of the necessity of doing his own hatching, may work against his interests if the work is not well done or if the chicks purchased are of inferior breeding and come from diseased stock. Fortunately, a rapidly increasing number of hatchery-men and individual breeders realize the importance of good breeding and freedom from disease, and are doing all they can to secure the highest degree of quality in the chicks they sell.

More and more, as a result of modern conditions, the experienced poultry-keeper as well as the beginner, regardless of the size of the flock, is faced with the problem of deciding whether he will be a breeder and hatch from his own stock, or confine himself to the production of eggs and meat and let

someone else do the breeding and hatching. There are good arguments on both sides of the question. Very often, when the flock is small, the owner feels that he does not want to be bothered with setting hens or an incubator. Many times there is no place suitable for an incubator or the owner does not feel qualified to operate it. Then there is the investment in an incubator which is only used for a short period each year. This is a very important item on a large poultry-farm, as not only the incubators must be considered but the expense of a building for them as well. There is also a certain advantage in having the season's quota of chicks arrive at one time, for many growers are able to raise them more successfully when all are of the same age.

On the other hand, a number of poultry-keepers realize the importance of well-bred disease-free stock and the difficulty in securing it, and feel that it is an advantage to breed their own stock and do their own hatching. In the first place, by so doing they are sure of the quality of their chicks and the time of hatch. On many of the larger farms, the sale of baby chicks usually results in very good pay for the time spent, and good interest on the investment.

If, after due consideration of the problem, the operator decides to do his own hatching, the amount and type of equipment necessary will depend on the number of chicks to be hatched and the extent of his breeding operations.

On farms where less than 100 chicks are raised, the natural method may be used to advantage. As far as average results are concerned, there is little choice, however, between hens and incubators. It is more a question of expense and convenience than one of efficiency. Incubators have the advantage of making it possible to hatch at any season of the year, without having to wait for a hen to become broody. Artificial incubation is the only practical method when large numbers of eggs are incubated.

CHOOSING AN INCUBATOR

If the operator has had experience in operating incubators the selection of an incubator may not be a problem; but for the novice this may be more difficult. In such cases the best procedure is to visit users of different makes who are known to be successful, and be guided by their experience. The County Agent and the State College poultry extension specialist can also be consulted.

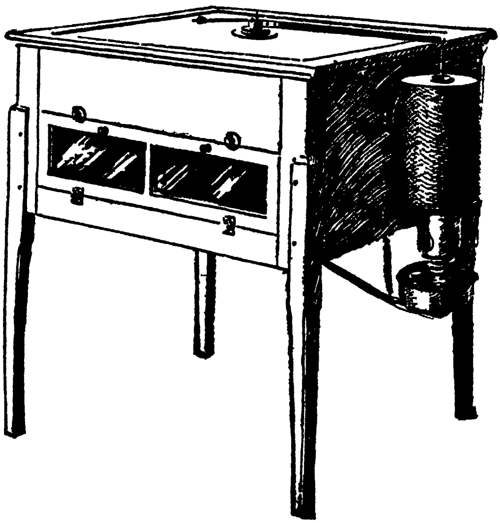

Fig. 41 A small hot-air incubator. The egg-chamber is warmed by hot air from the lamp.

The small incubators are generally heated by electricity

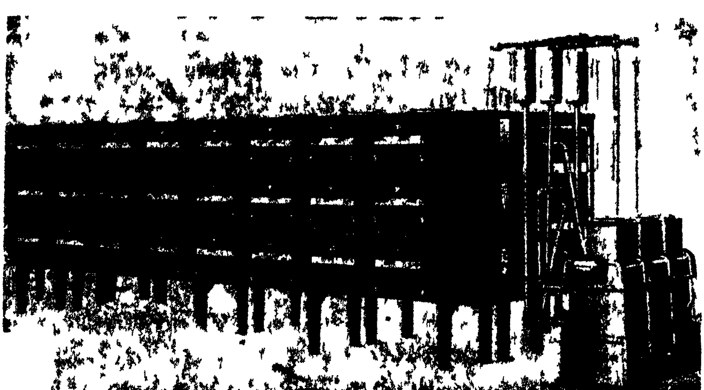

Fig. 42. A triple-deck sectional mammoth incubator. Each deck is heated and regulated independently and supplemented by individual compartment regulation and ventilation. (Newtown Incubator Co)

or with hot air or hot water by means of kerosene lamps. Many of the small incubators are now of the forced-draft type. Small cheap incubators should be avoided, for, due to their poor construction, they are sometimes difficult to operate successfully.

SECTIONAL MAMMOTH INCUBATORS

The sectional mammoth incubators are the oldest type of large incubator in use. They are gradually disappearing, as few if any new ones are being manufactured. They consist of sections or compartments resembling several small incu-

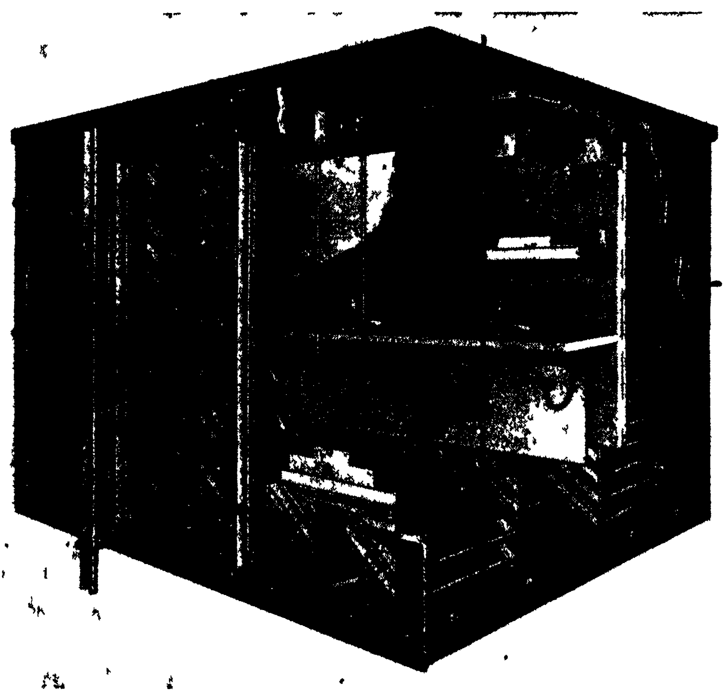

Fig. 43. Phantom view of cabinet Buckeye incubator (setting unit) Showing how eggs are set and automatically turned in less than five minutes. Note the fans in the central heating chamber which constantly force fresh air down through the electric heaters and then around the eggs from bottom to top of the egg chamber. Moisture is supplied by an automatic humidifier A (Courtesy of Buckeye Incubator Company.)

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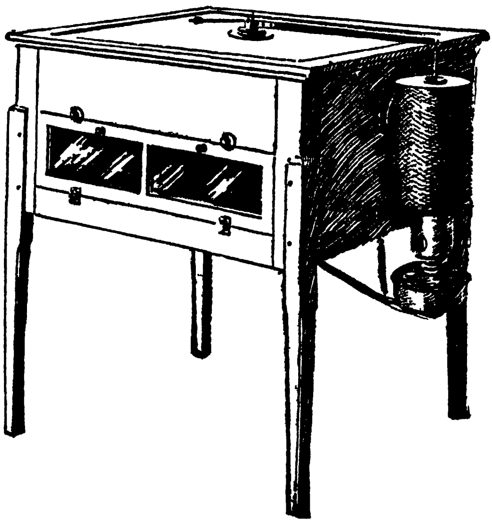

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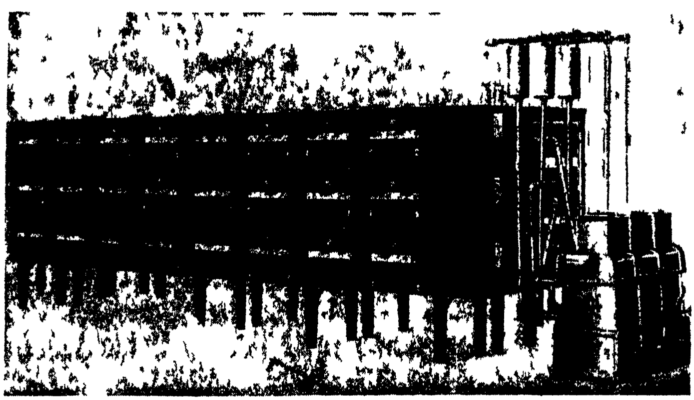

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or with hot air or hot water by means of kerosene lamps. Many of the small incubators are now of the forced-draft type. Small cheap incubators should be avoided, for, due to their poor construction, they are sometimes difficult to operate successfully.

SECTIONAL MAMMOTH INCUBATORS

The sectional mammoth incubators are the oldest type of large incubator in use. They are gradually disappearing, as few if any new ones are being manufactured. They consist of sections or compartments resembling several small incu-

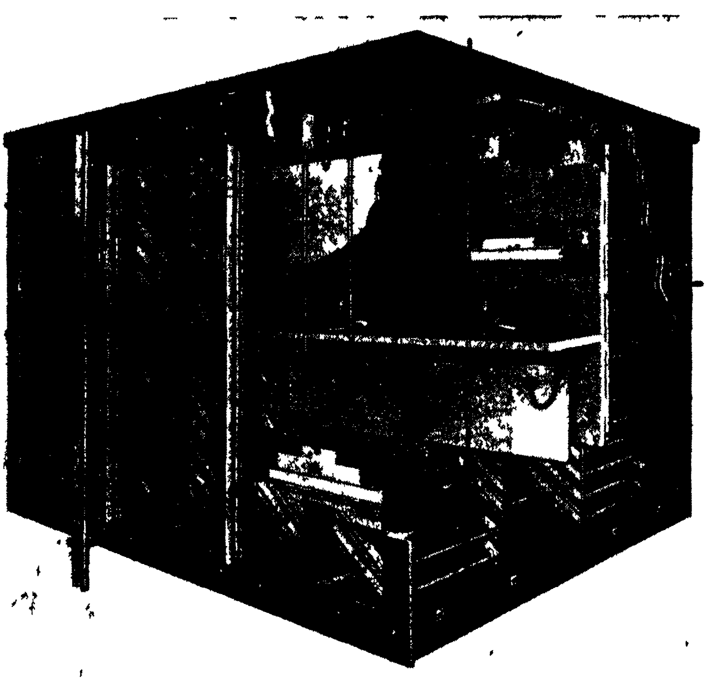


Fig. 43. Phantom view of cabinet Buckeye incubator (setting unit). Showing how eggs are set and automatically turned in less than five minutes. Note the fans in the central heating chamber which constantly force fresh air down through the electric heaters and then around the eggs from bottom to top of the egg chamber. Moisture is supplied by an automatic humidifier A. (Courtesy of Buckeye Incubator Company.)

bators joined together, regulated and operated independently but heated by one hot-water system operated from a central heater.

The principal fuel is coal or kerosene, although gas and electricity are sometimes used.

In most incubators of this type the eggs on one side are turned by means of a sliding section on the bottom of the trays, which is fastened to a shaft reaching the full length of the incubator and moved by a crank at the end.

Even when built with two, three, or four decks, one above another, this type of incubator occupies considerably more floor space, for the egg capacity, than the cabinet mammoth incubators.

CABINET OR FORCED-DRAFT MAMMOTH INCUBATORS

This type of mammoth incubator is a great improvement over the sectional machines, and is fast replacing them because the temperature, humidity and ventilation are better controlled, turning of the eggs is easier and faster, they are less

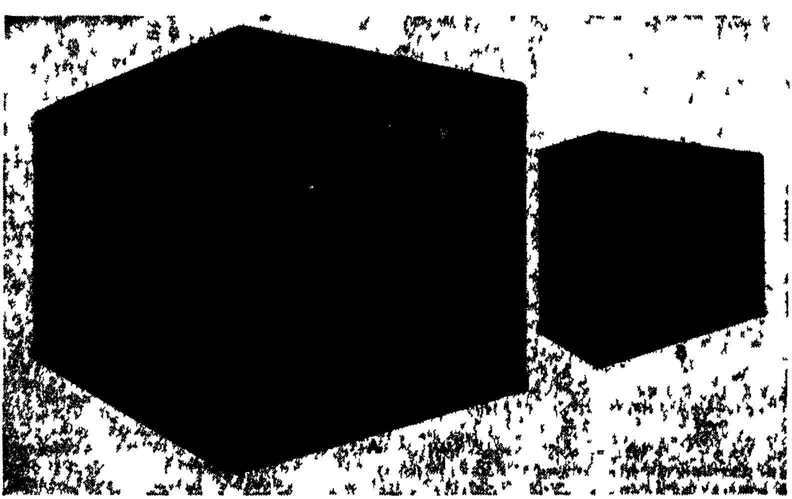


Fig. 44. Outside view of setting unit A shown in Fig. 43 and separate hatcher B.

affected by room temperature, and they occupy less floor space.

Cabinet incubators are built in the form of a large box or room.

PETERSIME HATCHIBATOR Model No. 20-D

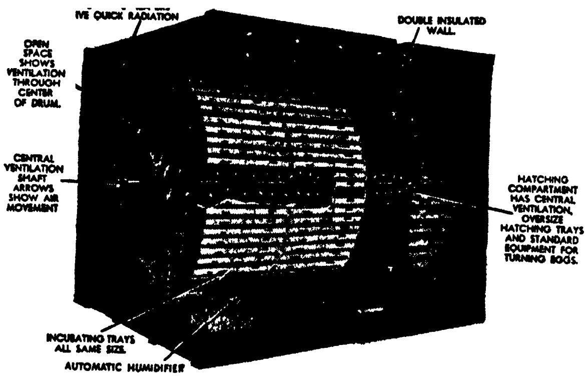


Fig. 45. Inside view of the Petersime cabinet incubator showing the setting unit with separate hatching compartment. Note the cylinder for the trays of eggs and the blades which stir the air around the cylinder. The eggs are turned by means of a lever on the side. (Courtesy of Petersime Incubator Company.)

The eggs are placed in trays from top to bottom of the machine. This makes it possible to put a large number of eggs in a small space and have good ventilation, temperature and machine control.

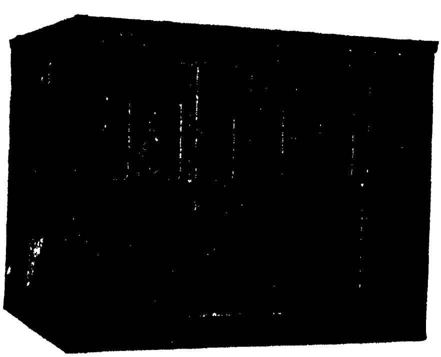


Fig. 46. Outside view of setting unit shown in Fig. 45 and separate hatcher.

The eggs are turned either by tilting several trays at one time to an angle of forty-five degrees in a specially constructed rack, or by means of a lever on the outside which changes the position of all the trays at one time by turning a drum in which they are set. This method of turn-

ing the eggs is easier and more thorough than the devices in use in sectional incubators.

The heat for cabinet incubators is supplied by coal, oil or electricity. Usually electric current is most often used, since it is required to operate the fans or paddles which agitate the air in the incubator. The temperature is kept uniform by means of sensitive automatic temperature-regulating mechanisms and electric fans or paddles which stir the air.

The required amount of moisture in most cases is furnished automatically by devices which spray water or pass humidified air into the incubator. The relative humidity is determined by wet-bulb thermometers.

A recent development is a separate compartment or hatcher to which the eggs are transferred two or three days before hatching. This permits a slightly lower temperature to be maintained at hatching and provides an opportunity to disinfect both incubator and hatcher separately.

The use of electricity in regulating, ventilating and heating this type of incubator limits its use to sections in which electricity is obtainable. It is also a disadvantage when the power is undependable or high in price.

The final choice of an incubator will depend on three things: the capacity needed, with allowance for possible expansion; the capital available; and the fuel, power, and facilities at hand.

LOCATING THE INCUBATOR

All types of incubators operate best in a well-ventilated room free from drafts where the temperature is uniform at about 70° F. This is particularly true of the smaller still-air and sectional incubators which are more affected by temperature changes, particularly low temperatures. A cellar or basement is the most desirable place for such incubators, because it is well protected from the sun and sudden changes in temperature. When a cellar is not available, a room above ground in a well-insulated building can be used.

Cabinet incubators are less affected by room temperatures, and consequently are more often installed in rooms above ground. A room temperature of 70° to 75° F. will provide more comfortable conditions for the operation of such machines and reduce fuel consumption in operating the incubator.

An ideal incubator room should have as high a ceiling as is practical, from 8 to 10 feet being good.

Ventilation and light can be obtained by locating windows around the room near the ceiling. These windows may be arranged to slide up and down, or they may be hinged at the bottom so that they will open at the top.

If a cellar is used, a wide hatchway, covered with hinged doors, should approach it from one side, preferably the sloping side if there is one.

The cellar door should be wide to permit large objects to pass, and well insulated and fitted to keep out heat and cold. A tile water drain from one side or the center of the cellar floor is desirable.

SECURING HATCHABILITY

More often, poor hatches are due to weak embryos or infertility than to faulty incubation. It is impossible to overemphasize the importance of vigor and health in the parent stock, together with proper feeding and management. (See Chapter XI, page 235.)

Not all eggs produced by most breeding flocks are satisfactory for hatching. Only those that meet the requirements of the best market grades should be saved. (See Chapter XIV, page 277.)

CARE OF HATCHING EGGS

Eggs for hatching should be gathered three times daily to protect them from extreme cold or heat. They should be kept in a clean, cool room where the temperature is between 50° and 60° F. and the relative humidity at least 70 per cent. Hatch-

ability is seriously affected if the eggs are held for a few days at temperatures ten degrees higher or lower than the extremes mentioned above. At 68° F. slow embryonic development occurs. This results in high embryonic mortality previous to incubation and during incubation.

Ventilation is desirable as long as it does not raise the temperature or lower the humidity.

The fresher the eggs when they are set, the better they will hatch. Under favorable conditions, hatching eggs will keep fairly well for fourteen days; but seven days is better.

It is usually considered good practice to turn eggs daily while they are held for hatching. A standard thirty-dozen egg-case makes an excellent container in which to save eggs. By turning the case first on one side and then on the opposite side on alternating days, sufficient turning is provided.

Rough handling or severe shaking or jarring of hatching eggs should be avoided, as it reduces the hatchability. Results at the National Agricultural Research Center, when hatching eggs were jarred, showed that the hatchability of eggs with tremulous air-cells was 20 per cent less than that of eggs with normal air-cells. It was further observed that tremulous air-cells were more likely to occur when the eggs were jarred with the large end down. Consequently, eggs for hatching should always be packed in cases with the small end down. This is particularly important if the eggs are shipped.

Slightly soiled hatching eggs should be dry-cleaned by scraping or scouring before they are set. They should not be washed, as washed eggs lose weight rapidly. Very dirty eggs should be discarded.

INCUBATION PERIOD

The period of incubation varies with different species of poultry. The following table gives the length of the period in days:

TABLE XVI

PERIOD OF INCUBATION

KIND OF POULTRY	DAYS	KIND OF POULTRY	DAYS
Hen	21	Peafowl	28
Pheasant	23–24	Guinea	26–28
Duck	28	Ostrich	42
Duck (Muscovy)	33–35	Goose	29–31
Turkey	28		

FORMATION AND STRUCTURE OF THE EGG

Before proceeding further with the operation of an incubator, a brief study of the egg itself may be of assistance (Fig. 47).

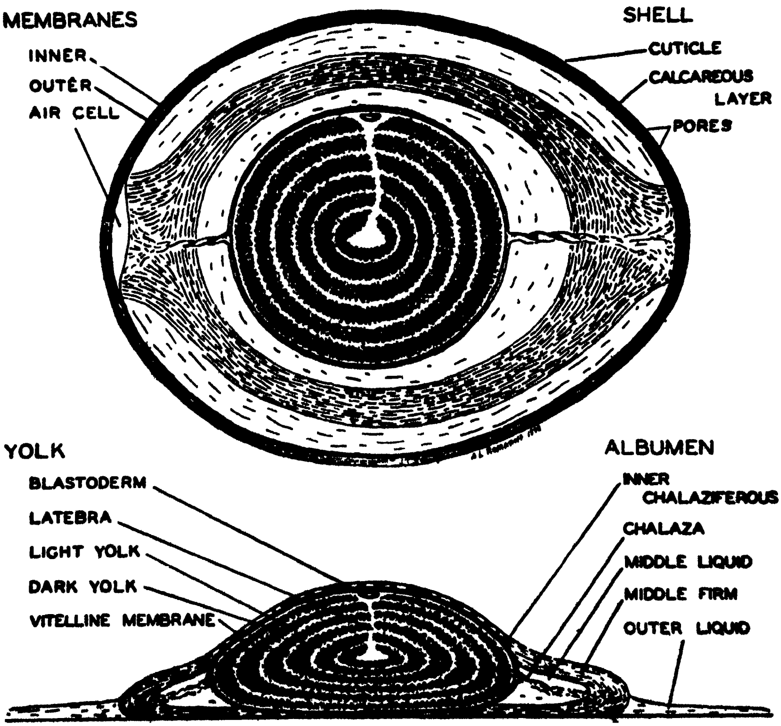


Fig. 47 Diagramic cross section of intact and opened eggs. (Drawing by Romanoff.)

The ovary of a hen is located near the back bone between the kidneys and the lungs, and contains many hundreds of minute yolks. At the proper time, some of these yolks start to develop in the ovary. An examination of a hen in laying condition will reveal several yolks in various stages of growth. Each yolk during its growth is enclosed in a sac, or follicle, which supplies it with nourishment by means of a network of tiny bloodvessels. At maturity, which occurs at about 7 days,[1] the yolk slips out of the follicle, when it opens along the suture line, and is enveloped by the funnel-shaped opening of the oviduct. It is at this point and before the white or albumen is laid on, that fertilization takes place.

The yolk then continues slowly down the oviduct, accumulating about 40 per cent of the albumen by the time it has passed through the first half. At this point the yolk enters the "isthmus," where the shell membrane and from 10 to 20 per cent more albumen are added. By this time the egg begins to assume its final shape and size.

The developing egg then passes into the uterus, where the remaining albumen, about 40 per cent, is added and the covering or shell is formed. As the egg passes through the vagina, the color pigment of the shell and certain gelatinous coatings that appear on the shell are added. The fully formed egg is then ready to be expelled through the cloaca.

The normal time required for the formation of an egg is as follows: three hours for the formation of the albumen in the first half of the oviduct; three hours for the formation of the shell membrane and a portion of the albumen in the isthmus; and fifteen to seventeen hours for the remaining functions in the uterus and vagina, including the laying of the egg. This makes a total of twenty-one or more hours.

An egg contains several distinct parts. The yolk, located near the center of a fresh egg, may be light or dark yellow in color, depending on the food the hen receives. The ger-

[1] According to Dr. Romanoff, Cornell University.

minal disk, the point at which the germ of the fertilized egg develops, appears as a small light-colored spot about 1/16 to 1/8 inch in diameter on the upper surface of the yolk. Nature seems to have so constructed the yolk that, no matter how the egg is moved, the yolk will quickly turn, so that the germinal disk is on the upper side.

This brings the germ nearer the source of heat from the hen. Eggs are turned, both by the hen and in artificial incubation, during the period of incubation to prevent the yolk (being lighter than the albumen) from rising and sticking to the shell membrane, to equalize differences in temperature, and to facilitate the development of the embryo.

Surrounding the yolk is the white, or albumen. The chalazæ, small white twisted cords of thick albumen, are attached to opposite sides of the yolk and act as anchors to hold the yolk in place.

Two fibrous membranes enclose the white with the yolk and help to keep the egg contents in shape. These thin membranes separate at the large end of the egg to form the air-cell.

The outer covering, or shell, is composed of very porous calcareous material about 1/16 inch in thickness. Because of the porosity of the shell, evaporation takes place rapidly during incubation if the amount of moisture and ventilation is not just right.

The composition of an egg[2] (without the shell) is as follows:

Water	73.7%
Fat	10.5%
Protein	14.8%
Mineral matter	1.0%

THE DEVELOPMENT OF A CHICK EMBRYO

The growth and development of the chick embryo is a very interesting process. Fig. 48 shows the development of an

[2] Rice and Botsford, "Practical Poultry Management." The composition of eggs is variable.

embryo from the time fertilization takes place until the chick hatches.

Critical periods in the life of the embryo. Romanoff,[8] in discussing the growth of the embryo, brings out the important

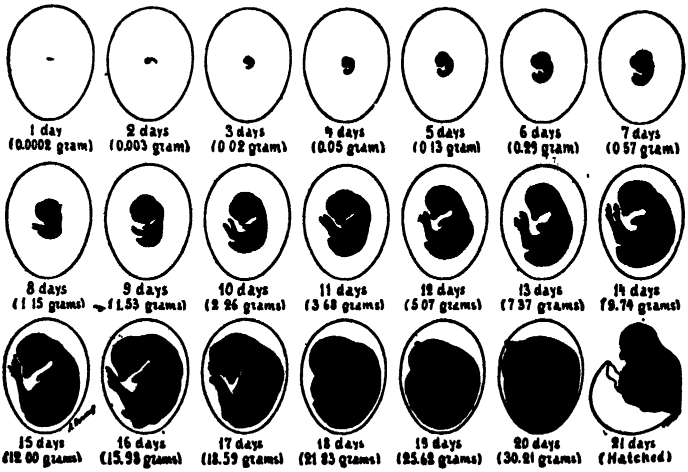


Fig. 48. Daily changes in the weight and form of the developing chick embryo (White Leghorn). With the yolk-sac the hatched chick weighs about 40 grams.

point that there are two dangerous periods in its development. He says:

"During development structural conditions within the embryo are constantly changing. Each phase of the embryonic development presents a new complex of conditions and sometimes injury.

"It has been observed that during incubation embryos are injured more frequently in certain periods of development than in others. Many embryos, being naturally weak, die at these particular periods, which might be called critical periods.

"Furthermore, the embryonic mortality is found to be much greater at the second critical period than at the first. Under ordinary conditions of artificial incubation, an average of about 3 embryos in 100 die at the first critical period, about

[8] From Cornell Extension Bulletin 205.

15 at the second, and about 7 during the rest of the incubation period (Fig. 49 [4]). Under exceptional conditions the mortality at each critical period may vary from almost 0 to 100. This variation depends, however, primarily upon the vitality of the embryos.

"In general, the environment prior to incubation may either destroy the embryo or lower the vitality of the embryo later on during incubation. When a fertilized egg is set for incubation, the embryo resumes its development. The incubation environment, particularly temperature, humidity, purity of air, or ventilation, is very important to the growing embryo."

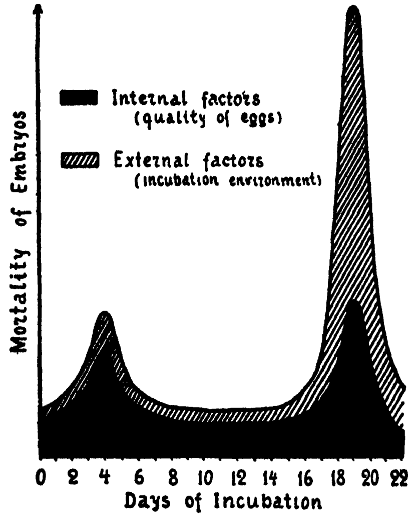


Fig. 49 Distribution of embryonic mortality in artificial incubation.

Much of the success in artificial incubation, therefore, depends on the skill of the operator, the operation of the incubator, the stock, and the way in which the eggs are handled previous to incubation.

PREPARING AN INCUBATOR FOR OPERATION

Unless the operator has had considerable experience, it is best to follow the rules outlined by the manufacturer when operating an incubator. There are a few points, however, in the care and operation of an incubator that it may be well to mention.

If the incubator is old and not thoroughly cleaned at the end of the hatching season, it should be dry-cleaned and disinfected as described on page 119. Disinfection does not increase

[4] From Cornell Extension Bulletin 205.

the hatch, but it kills disease germs, especially pullorum-disease germs which are so destructive to chicks.

It is a good plan to test the incubator with a carpenter's level to see whether it is level. This is particularly true of small machines, but it may be applied to large ones to some extent because the floor may settle or something may happen from season to season to throw it out of level.

The hot-water system in a mammoth incubator should be flushed out to prevent the collection of sediment and scale or rust in any part of the system and the possible clogging of valves. The use of soft water will prevent deposits of lime on the inside of the pipes.

TESTING THE THERMOMETERS

The thermometers should be checked previous to use each year. One or two degrees of variation from the correct temperature may seriously affect a hatch.

Thermometers are tested by putting them in a pan of warm water registering 100° F. by a thermometer known to be accurate, such as a clinical thermometer. The bulbs of the thermometers are placed close together and the water is stirred to get an even distribution of the heat and an accurate reading. Thermometers that vary more than one-half of a degree from the correct temperature should be discarded or carefully marked so that no mistake will be made in using them.

Sometimes new thermometers are found to be inaccurate. Since the thermometer in cabinet incubators is stationary, a clinical thermometer may be placed inside the machine to make the test.

The operator should be sure to place the thermometer in the exact position described in the rules sent out by the manufacturer, and keep the temperature at the point recommended.

All types of incubators should be operated for a few days, or until the operator is satisfied that everything is in perfect working order, before the eggs are set. Particular attention

should be given to the thermostat and heater in still-air machines; and in the cabinet incubators the air distributors, moisture apparatus, and electrical connection should be checked.

In small incubators, when oil lamps are used a new wick should be provided at the beginning of the hatching season. The burner should be cleaned twice daily to remove the char which may cause the flame to climb and smoke. High-test kerosene oil is desirable for such lamps if procurable. The isinglass in the lamp chimney should be cleaned (if dirty) with a cloth dampened with vinegar.

Starting the hatch. Some thought should be given to the day of the week and the time of day when the hatch is started, for if the chicks hatch on time they will be ready to move three weeks later at the same time. Eggs should not be set to hatch on Saturday or Sunday, especially if the chicks are to be sold. Saturday is a poor day to ship because the chicks are not likely to be delivered until Monday.

The eggs may be trayed as fast as gathered in the egg-cooling room or just before they are placed in the incubator.

If the eggs are brought directly from the egg-room (where the temperature is between 50° and 60° F.) and placed in a still-air incubator, it will usually require from ten to twelve hours to warm them to the proper incubation temperature. In the cabinet forced-draft machines the eggs warm up more rapidly. Some operators hold the eggs in a room at 70° F. for about half a day before they are set. By this procedure the change to a higher temperature is more gradual, and less time is required to bring the eggs to incubation temperature.

Temperatures above normal will result in premature hatches, and lower temperatures in delayed hatches. When a still-air incubator is set at night without warming the eggs to room temperature, the following day is considered the first day of incubation. The hatch should be complete on the morning

of the twenty-first day. The hatching time may be advanced slightly by pre-warming the eggs. The hatch should be complete on the morning of the twenty-second day in a forced-draft incubator which has both eggs and hatching trays in the same compartment, when the eggs are pre-warmed and set early in the morning of the first day.

Under normal conditions, the hatch of eggs from the Mediterranean breeds (white eggs) may be almost complete by the end of the twentieth day; whereas the American breeds (brown eggs) continue until the twenty-first day. The Asiatic breeds sometimes take eight to twelve hours longer. The eggs may be placed in the incubator trays on their sides or on end, but always with the large end up.

THE OPERATING TEMPERATURE

Small or sectional incubators. In this type of incubator the egg chamber is warmest near the top and coolest near the bottom. If the thermometer hangs so that the bulb is above the eggs, it should be operated at a higher temperature than when the bulb is on a level with the eggs. The bulb of the thermometer should never touch the eggs, because the temperature of the eggs is much higher than the temperature of the incubator.

Still-air incubators should be operated at about the following temperatures when the room temperature is 60° F. For room temperatures 20 degrees higher or lower, decrease or increase the incubator temperature one-half degree.

STANDING OR HANGING THERMOMETER

First week	102.5° F.
Second and third week	102° F.
Eighteenth day to end of hatch	100°–101° F.

The above temperature readings should be made when the bulb of the thermometer is about 2 inches from the egg-tray level. The readings should be increased or decreased if the bulb of the thermometer is higher or lower than 2 inches. These

recommendations may not apply to incubators having a very rapid or slow exchange of air in the compartment because of their variable construction.

CABINET MAMMOTH OR FORCED-DRAFT INCUBATORS

The temperatures vary in the different makes of incubators; consequently, the manufacturer's directions should be followed closely. In machines where the hatching and incubating of the eggs are done in the same compartment, the temperature cannot be lowered on the eighteenth day because of the harmful effects on the partly incubated eggs remaining in the incubator. Such machines should be held at 99.5° F. throughout the period of incubation.

In incubators with separate hatchers the temperature should be carried at from 99.5° to 99.7° F. for the first two weeks, and dropped on the eighteenth day to 98° to 99° F.

Satisfactory hatches are often obtained even though the temperature may accidentally exceed or drop below the normal temperature four or five degrees for a few hours. This applies particularly to the latter part of the period of incubation, during which the embryo apparently can withstand such extreme fluctuations with less danger of being killed.

THE OPERATING HUMIDITY

All types of incubators give the best results when the relative humidity is maintained at from 55 to 60 per cent to the eighteenth day, and increased 5 to 10 per cent after that time.

Relative humidity means the percentage of saturation of the air with water vapor. For example, a relative-humidity reading of 60 per cent indicates that the air contains 60 per cent of the water it is possible for it to hold at that temperature. The amount of water vapor the air can carry varies with the temperature. Higher temperatures require larger amounts of water for full saturation, while lower temperatures take less.

At the time incubation starts, the egg content contains about 73.7 per cent water.

Under normal conditions, as the process of incubation progresses, the water in the egg slowly evaporates, causing the air-cell to enlarge. Eggs containing live germs and losing from 12 to 15 per cent of their original weight during the period of incubation are considered to evaporate normally. If the rate of evaporation is too fast or too slow, the development of the embryo is seriously affected. In either case, the hatch may be impaired. The problem of the operator is to be able to tell whether evaporation is normal and to correct abnormal conditions. This has been greatly simplified in the modern forced-draft incubators by the use of wet-bulb thermometers and automatic humidifiers. Most operators try to keep the wet-bulb reading about 85° to 87° F. during the first eighteen days of incubation, and 87° to 89° F., or about two degrees higher, while the chicks are hatching. There must be rapid circulation of air to give a correct reading of the wet-bulb thermometer; consequently, this method of measuring humidity cannot be used in the still-air incubators. The humidity in such machines may be determined either by watching the size of the air-cell during incubation or by the use of a hair hygrometer. The former method requires an observing eye, and experience. The size of the air-cell varies normally, during the period of incubation, from about the size of a ten-cent piece in an egg one day after incubation starts, to a space on the eighteenth day as large as a half-dollar.

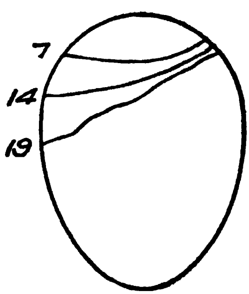


Fig. 50. Diagram showing the air-cell on the seventh, fourteenth, and nineteenth days of incubation.

When a hair hygrometer is used, it should be at least four inches in diameter. Hair hygrometers are fairly accurate when a long hair is used. Hygrometers with metal springs are less accurate.

Since there usually is no automatic control of the humidity in still-air incubators, if evaporation is too fast it may be

reduced by placing shallow pans of water in the bottom of the machine or by keeping the floor of the incubator room wet. On the other hand, if greater evaporation is desired, more air may be allowed to circulate through the egg chamber by opening the ventilators.

The amount of water to be supplied will depend to a large extent on the climate, the season, the surroundings, and the type of incubator. Under average conditions, there is more likelihood of too little moisture than of too much.

More moisture is usually needed in mountainous sections, where (on account of the altitude) the air is dry. Most cellars or rooms with concrete or board floors require additional amounts of moisture.

TURNING THE EGGS

The turning of the eggs during the period of incubation is very important. This should be done at least three or four times a day in all types of incubators, beginning on the second day after the eggs are set and continuing until the nineteenth day. More frequent turning may result in slightly increased hatches, but is not practical.

By turning the eggs frequently, the egg yolk, with the embryo, is prevented from sticking to the shell membrane. It is not necessary to turn the eggs completely over; a quarter turn will do. The hen changes the position of the eggs under her several times a day.

All cabinet and most sectional incubators have mechanical devices which permit quick turning or tilting of the eggs in the incubator.

COOLING

Although the mother hen cools her eggs during incubation, tests show that it is unnecessary to cool eggs in incubators except when they are accidentally overheated.

VENTILATION

Proper ventilation of the incubator is important for four reasons: (1) it regulates the temperature; (2) it is the way in which the developing embryo is supplied with oxygen; (3) it provides a means of reducing or removing the carbon dioxide in the egg chamber; (4) it helps to regulate the moisture supply.

Oxygen is a very important element to the developing embryo. On the other hand, carbon dioxide (CO_2) has a detrimental effect on the embryonic development. The oxygen requirements of the embryo increase as it develops. Likewise the amount of carbon dioxide produced increases as the embryo grows; consequently, the need for adequate ventilation increases as the period of incubation progresses. This is particularly true of still-air incubators. Modern forced-draft incubators have the air well equalized in the egg chamber by agitators, and the carbon dioxide better controlled through their automatic ventilation systems.

As ventilation is increased in the later stages of hatching, more moisture must also be provided.

TESTING THE EGGS

Testing the eggs may be advisable in small or sectional-type incubators, but is not practical in the forced-draft mammoth incubators. Some operators may check the fertility of different lots of eggs after they have been in the machine a few days by examining a few, or they may test on the eighteenth day while changing the eggs to the separate hatcher to conserve space.

The testing, or candling, is done in the manner described in Chapter XIV (page 274). Some operators remove the trays and pass a strong light under them. This quickly shows up infertile eggs and those with dead germs. The first test is made on the fourth or fifth day for white eggs, on the sixth or seventh

day for brown eggs. A second test may be made about the fifteenth day, but is usually unnecessary.

FINISHING THE HATCH

In the still-air incubators the doors should be kept closed after the last turning on the eighteenth day, to conserve moisture. The covers over the holes leading into the nursery trays should be removed so that the chicks when dry may drop into the trays. If the moisture pans are not protected, they should be removed when the hatch is about two-thirds over. Ample ventilation should be provided.

If the incubator is needed for another hatch immediately, the chicks may be removed to chick-boxes and "hardened off" there. When the chicks are "hardened off" in the incubator, it may be necessary (if the hatch is a good one and the weather is warm) to open the doors a little to reduce the temperature. As soon as the hatch is over, the eggs that failed to hatch and the empty shells should be removed.

In the forced-draft incubators the chicks remain on the hatching trays until they are dry. They are then sorted and counted directly from the trays into chick-boxes ready for sale, shipment, or the brooders. The sorting should be done in a warm, comfortable room to prevent chilling. Care should be taken to see that the chick-boxes are properly ventilated. Only a few holes should be punched if the room or the weather is cold; but all possible ventilation is necessary if the surroundings or the weather is hot.

CLEANING UP THE INCUBATOR

After each hatch, all the portable parts of the incubator should be removed, dry-cleaned, and scrubbed with water. Down and dust may be removed with a vacuum cleaner. After the movable parts have been soaked for thirty minutes in a three-per-cent creosol solution, they should be returned to the incubator. The machine is then ready to be fumigated.

Fumigation has become the generally accepted method of disinfecting modern forced-draft incubators. It is performed with or without eggs and with chicks in the incubator. Directions for fumigating their particular machines may be obtained from almost all incubator manufacturers.

There are two methods of fumigation which give equally good results. One is known as the "Permanganate" and the other as the "Cheesecloth" method. In either case formaldehyde gas is the germicidal agent.

When these methods are used, it is important that the incubator be operated at a temperature of 96.5° to 100° F., and that the wet-bulb reading be above 86° F. when fumigating with or without eggs and 90° to 93° F. when fumigating chicks. Fumigation is not so satisfactory in still-air incubators, as the gas does not mix readily with the air without the agitators.

To carry out the potassium-permanganate method of fumigation in a forced-draft incubator (with or without eggs), first determine the number of cubic feet of air space in the incubator, using the outside measurements. For each 100 cubic feet to be fumigated, use 35 c.c. (1⅙ ounces) of formalin and 17.5 grams (0.6 ounces) of potassium permanganate.

"A simple way to determine the required amounts of chemicals is to use the following chart. A set of household measuring spoons and cups serve well for measuring the amounts required."[5]

Cubic Feet of Air Space	Amount of Formalin	Amount of Potassium Permanganate
10	1 teaspoonful	½ teaspoonful
20	2 teaspoonfuls	1 teaspoonful
50	5 teaspoonfuls	3 teaspoonfuls
100	¼ cup	⅛ cup
200	½ cup	¼ cup
400	1 cup	½ cup

[5] Dr. E. L. Brunett, "Poultry Diseases," Cornell Extension Bulletin 337.

The mixing of the two chemicals starts a chemical action which results in much heat and the formation of formaldehyde gas. Because of the violence of the action, over-sized enamelware pans or crocks should be used. Place the pans under the fans as directed by the manufacturer. When everything is in readiness, pour the formalin over the potassium permanganate, then close the doors of the incubator but leave the ventilators open as usual. There is sufficient time to do this before the gas becomes too strong for comfort. See that the fans are running, so that this gas is properly diffused. This is very important when chicks are fumigated.

Unless the fumigation is done at the end of the day, when the operator will be out of the room for some time, the gas can be neutralized after seven minutes with strong ammonium hydroxide (26 per cent). The ammonia may be placed under the intake or absorbed by cheesecloth and hung in the machine, using one-half as much ammonia hydroxide as formalin.

Eggs may be fumigated twice each week until hatching time, without injurious results.

The procedure when chicks are fumigated is the same, except that the wet-bulb reading *must not be less* than 90° F., and it should be done while the chicks are still moist. Unless the humidity is high, the result will be disastrous. The first fumigation should take place when 15 to 20 per cent of the chicks have hatched, and should be repeated at 12- to 15-hour intervals until the hatch is finished. The chicks should never be fumigated a second time, or after they are one day old. The wet chicks may remain in the incubator for 8 to 10 hours after fumigation if the wet-bulb reading is 92° to 93° F. Some hatchery-men prefer to neutralize the gas with ammonia after 5 to 8 minutes, as directed above.

When the "Cheesecloth" method of fumigation is used, 20 c.c., or ⅔ of an ounce, of formalin is used for each 100 cubic feet of incubator space. Pieces of cheesecloth approximately a yard square, or of the size recommended by the incubator

manufacturer, are soaked in the formalin so that all the required amount is absorbed without dripping. The cloths are hung as directed, usually under the fans, until dry.

The same precautions should be taken with this method as described above with the "Permanganate" method.

To fumigate a still-air incubator after the hatch has been completed, clean the inside of the machine and all the parts thoroughly. See that the temperature in each compartment is between 99° and 100° F., and that the interior is moist or showing about 68 per cent relative humidity on a hair hygrometer. Close the ventilators and place an enamel-ware cup in each compartment. Measure out the right amount of potassium permanganate and add the formalin, as directed in the table above. Keep the door of the compartment closed for 30 minutes while the gases diffuse. Fumigating chicks in still-air incubators is not recommended. It is not advisable to leave a hair hygrometer in the incubator during fumigation.

Small incubators and sectional incubators may also be disinfected by drenching the interior and soaking the movable parts with a 3-per-cent creosol solution.

Fumigation of the chicks is not a desirable practice. It will reduce the spread of pullorum disease among chicks of the same hatch while still in the incubator, but will not cure diseased chicks nor eliminate the possibility of future infection. Nothing can be done to reduce the infection already inside the chick. Clean chicks can be secured only by hatching eggs from clean parent stock. (See Chapter XVII, page 467, for method of testing breeding stock.)

If there is much trouble with mushy chicks (omphalitis), fumigate the eggs with two and one-half times the usual amount of chemicals at the time the eggs are transferred to the hatching compartment.

SEXING CHICKS

The sex of a baby chick may be determined at hatching

time by everting the vent of the chick and looking for the presence or absence of a tiny rudimentary copulatory organ on the inside rim.

The most favorable age for making the examination is five to fifteen hours after hatching, or as soon as the chicks have dried off and have gained strength enough to be handled.

The examination is made rapidly by an expert and without injury to the chick. A magnifying glass or lens is unnecessary. A competent sexor will determine the sex 98 per cent correctly, and will examine 500 or more chicks per hour. Most sexors receive one-half cent per chick for sexing.

To become an expert sexor the individual must be young, have patience, persistency, good eyesight and nimble fingers.

The copulatory organ of the chick varies in shape, color and size. Organs will be found in both males and females; but generally the ones (comparatively) of considerable size are males. A little over half of the females have no visible organs, and others have either very small ones, about the size of pin points, or slightly larger ones that appear flat, flabby or vaguely outlined. To become expert the sexor must learn to differentiate between the types and characteristics of the male and the female organs.

The chief advantage for the average poultry-keeper in buying sexed chicks is to avoid raising the cockerels. The buyer usually pays about twice as much for pullet chicks as for "straight-run" or unsexed chicks. Cockerel chicks are sold mostly for broiler purposes.

HATCHING WITH HENS

Natural incubation is still in use when a small number of chicks are to be raised. With this method the hen provides both the means of incubating the eggs and of brooding the chickens.

When the natural method of incubation is employed, it is advisable to select the hens carefully. Only hens in good health,

of quiet disposition and medium size, should be used. Hens from the general-purpose breeds such as the Plymouth Rocks, Wyandottes or Rhode Island Reds usually make the best setters and mothers. The heavy breeds, including the Brahmas and Cochins, make good setters, but, on account of their size, are inclined to be clumsy and awkward, often breaking eggs in the nest and trampling on the chicks afterward. Leghorns and similar varieties, being nervous and excitable, seldom make trustworthy setters. Hens usually set better than pullets.

Nests for setting hens should be placed in a quiet comfortable place away from those of the laying hens. The nest-boxes should be shallow and roomy to prevent the hens from breaking the eggs when leaving or returning to the nests. It is best to have them on the ground or to put sod under the nesting material for moisture. Shavings or fine hay make the best nest material.

Usually, when a hen clucks, ruffles up her feathers, and remains on the nest when approached, she wants to set. The poultryman should prepare a nest, treat her for lice by applying blue ointment or sodium fluoride as described in Chapter XIX (page 480), and move her after dark to the new nest. Three or four nest eggs should be put under her, but no good ones until after two or three days trial. Then, if she is inclined to set, thirteen or fifteen eggs may be placed under her. The number of eggs depends on the size of the hen and the season of the year.

Scratch grain, grit and fresh water should be kept handy so that the hen can eat when she likes. If eggs get broken in the nest, the shells should be removed and some of the nest material replaced. Eggs badly smeared with yolk should be washed. If several hens are setting in the same room, one should watch to see that they do not fight or remain off the nest too long.

After five or six days the eggs should be tested and those that are infertile or contain dead germs should be removed. If several hens are set at the same time, the eggs from two

or more hens can sometimes be placed under one individual after the infertile ones and dead germs are removed. The extra hens can then be set again, or returned to the laying flock after they have recovered from their broodiness.

The hen should not be disturbed at hatching time except once or twice to remove the empty shells.

If the hen is inclined to remain on the nest with her chickens for a few hours after the hatch is over, she should be allowed to do so, then removed to a brooder-coop.

PEDIGREE HATCHING

When a careful system of line-breeding is followed and it is necessary to know the parentage of each chick, pedigree hatching is practiced. This work requires considerable time and labor because of the large number of details involved in keeping the necessary records. The work can be simplified and errors avoided by following the method described below. Details are, briefly:

(1) Band each female and male in the pens where eggs are to be saved for pedigree hatching, with numbered bands which can be easily read.

(2) Use one male with the same hens throughout the period of hatching.

(3) Trap-nest during the breeding season.

(4) Record the number of each bird in a breeding-record book. A page should be allowed for each bird. A book with detachable leaves is preferable. Table XXXVI shows the form for a hen, Table XXXIX for a male.

(5) Mark the number of the hen and the pen on the large end of the egg as it is taken from the trap-nest; for example,
(1256) [6]
(2)

(6) Before the eggs are set, they should be placed on a table built especially for the purpose (see Fig. 51) and grouped.

[6] The upper figure is the hen's band number, the lower one is the pen number.

The egg-sorting table is very important, as it makes the work of handling and separating the eggs much easier and faster. The frame of the table is made of ordinary ⅞-inch pine

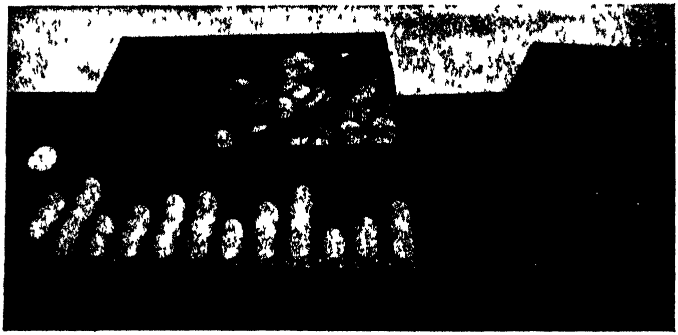


Fig. 51. Pedigree hatching. The end of an egg-sorting table. Before placing the eggs in the incubator, all the eggs from hens mated to a certain male are arranged on the sorting table in numerical order, according to the leg-band numbers of the hens. Each egg is then given a number. Note wire hatching baskets.

lumber. The legs consist of 2-by-4-inch material cut long enough so that the top of the table is at a good working height. Usually this should be 32 inches. The top is made of a wall board 30 inches wide and should extend to the outside edge of the frame. A table 60 inches long will accommodate the eggs from twenty-five hens.

Holes 1⅜ inches in diameter are bored through the top before it is nailed to the frame. There are twelve holes in each row across the table, spaced 2¼ inches apart from center to center. A margin of 1½ to 2 inches remains on all sides. The top of a table 10 feet long should be supported in two or three places by cross pieces nailed to the frame.

Facing the long way of the table and beginning at the left, the rows of holes are numbered from 0 to 25, inclusive. The rows of holes across the end of the table are then numbered from 0 to 12 inclusive.

All the eggs from hens mated to a certain male are arranged

on the sorting table in numerical order according to the leg-band numbers of the hens. The eggs from each hen are grouped together so that they may be placed in the incubator and on the incubator record sheet for quick reference. The following plan shows the method:

	Hen No.
Male No. 16	1201
	1220
	1302
	1401
Male No. 17	1218
	1306
	1422

Record the hatch number, date set, and number of eggs on the individual hen-pedigree sheet. Table XVII shows a suggested record sheet.

(7) Set the eggs in the incubator in the usual way, arranging them by trays in the same order as they were when laid out on the sorting table. It is a distinct advantage to have trays so constructed, if possible, that the eggs are laid out in rows.

(8) On the eighteenth day sort out all the eggs from each hen that remains after testing and place them in small wire baskets, or they should be arranged on the tray in numerical

TABLE XVII

Hatchability and Range Record in Progeny-Testing an Individual Hen

Year.......... Hen No......... Mated to Male No......... Pen No......

REARING RECORD				INCUBATION RECORD[1]					
Chick Band No.	Disposal of Chick	Chick Band No.	Disposal of Chick	Hatch No.	Date Set	Eggs Set	Infertile	Dead Germs	Chicks Banded
				Total					

Sire number

Dam number
Record—1st year eggs
2d year eggs
3d year eggs

Sire number

Dam number
Record—1st year eggs
2d year eggs
3d year eggs

Sire number

Dam number
Record—1st year eggs
2d year eggs
3d year eggs

PEDIGREE OF
Number

Sire number

Sire number

Dam number
Record—1st year eggs
2d year
3d year

Dam number
Record—1st year eggs
2d year eggs
3d year eggs

Dam number
Record—1st year eggs
2d year eggs
3d year eggs

Sire number

Dam number
Record—1st year eggs
2d year eggs
3d year eggs

SUMMARY

Birds culled (C) or sold (S) as meat
Birds lost by (A) accident
Pullets housed (H)
Cockerels saved or banded (K)
Total birds dead (D) to housing
Birds missing (M)
Note:—Record leg-band numbers in disposal column. Use symbols for disposal.

[1] % hatch of fertile eggs

order. Fig. 51 shows a pedigree tray with baskets. If there are more eggs from one hen than will go in one basket, a second one is used or divided by means of a strip of cardboard.

Fig 52 All chicks are banded with numbered bands. The numbers on the bands and the unhatched eggs are recorded on the incubator record sheet One man arranges the bands in numerical order on the spindles, then bends the bands, and lays them out in rows on the table. This man bands the chick while the other does the recording The recorder hands the chicks to the bander Note the cardboard over a part of the incubator tray This speeds up the work for the recorder After banding the chicks are placed in boxes

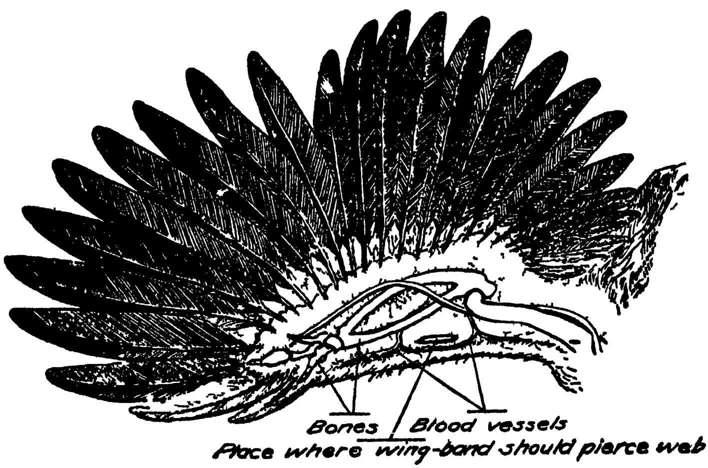


Fig. 53. Location of the wing-band, the spot where the web of the wing should be punctured for the band, in wing-banding chicks.

(9) When the hatch is over, remove the chicks from the baskets in regular order and band them with a small numbered band. The band is passed through the web of the wing (Fig. 53) and sealed on for life.

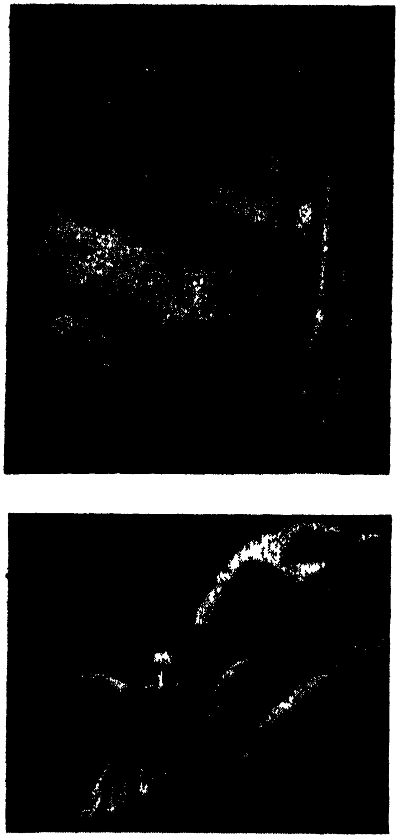


Fig. 54. Wing-banding a chick.

(10) Record the leg-band number of each chick on the pedigree sheet already mentioned.

The chicks are now ready to be brooded the same as other chicks.

VIII. Requirements for Brooding Chickens

THE best test of a successful poultryman is his ability to rear a thrifty flock of chickens. Because artificial devices have largely supplanted the task that nature has assigned to the mother hen, the person in charge takes on great responsibilities when hundreds of tiny individuals are so dependent upon his judgment and watchfulness. The caretaker must have a natural liking for detail as well as an inclination to stick close to the job. Furthermore, the ability to grow good chickens regularly is not acquired in one season; the skill is developed by years of experience, careful thought, a love for the work, and what some poultrymen call "chicken sense."

As a result of recent scientific discoveries in nutrition and of the inprovement in brooding equipment, it is much easier to grow chickens today than ever before. In fact, it is expected that a good poultryman will rear approximately 90 per cent of the chicks brooded.

Many failures in growing young chickens result from the proprietor not being able to realize what is required of him as general manager. If he recognizes this, he does not always feel that he can spend the time that is required to do the work efficiently. Such a person might better buy pullets than attempt to raise them.

The safest plan for the inexperienced person is to start in a small way and to follow some approved method. Many serious mistakes will be prevented, and at the same time a background of practical experiences will be acquired.

Given strong healthy chicks and good equipment, the limiting factor then, is the man in charge.

PLANNING FOR THE CHICKENS

Good breeding stock. It is impossible to overemphasize the necessity of starting with chickens from vigorous parents, free from disease, and bred-to-lay. When the breeding stock is vigorous, the chicks from such parents are more likely to be strong and healthy. It is difficult, if not impossible, to make a strong chicken out of one that is constitutionally weak.

Spring-hatched pullets. Usually the best time to hatch chicks anywhere in the United States is when the grass first shows green. April is the heart of the season. Leghorn pullets hatched early in March will usually begin laying in late August and are more likely to molt early the following winter. Late May and June chicks do not come into laying until the season of high prices in the fall is partly over. Very early hatched chicks are more expensive to brood than are later hatched ones because they require a longer period of artificial heat. On the other hand, more chickens are likely to be lost by disease when they are hatched in hot weather, because some of the organisms that cause chicken diseases are more active in warm than in cool weather.

The principal consideration is the time when the pullets will mature and begin to lay. On a well-managed poultry farm an even distribution of eggs is desirable throughout the year. Consequently, the pullets should be hatched early enough to have a chance to properly mature and begin laying before the bulk of the old hens stop laying in the fall.

That heavy fall production pays is verified in a report of 120 poultry-farm businesses which the Department of Agricultural Economics at Cornell University studied in 1940–41 (Chapter IV, page 45).

High-producing early hatched pullets will not only lay a large number of eggs as pullets during the fall and winter months but as hens they will end their laying year by producing more eggs during the season of high prices. At this

time their eggs will have the added value of being full sized.

Chickens hatched in the spring have the advantage of being able to run on pasture until mature, which not only reduces feed costs but provides them with an extra supply of vitamins.

Fall and winter rearing. Until recent years practically all pullets for replacements were raised in the spring. Under modern conditions pullets for these replacements may be hatched at other seasons of the year. September and October, or January and February, are good months.

The advantages of rearing pullets at different seasons of the year are the following: (1) It increases the efficiency of the business by making it possible to replace during the year birds that die or are culled. (2) Less brooding equipment is needed and more efficient use is made of it. (3) Egg production is more uniform through the year. (4) There is better yearly distribution of labor. (5) More chicks are produced from the same breeders.

The disadvantages are the following: (1) The cost of growing pullets is greater. (2) Pasture cannot be utilized fully. (3) Usually hatchability of eggs is lower in the fall and the winter. (4) There may be difficulty in maintaining production through the summer and fall.

The early hatching period has its advantages and disadvantages which vary greatly with localities and with breeds of poultry. Since all available information indicates that spring-hatched pullets are slightly superior in many respects to those hatched at other seasons of the year, probably it is not advisable to raise more than 20 to 25 per cent of the annual number of replacements during the fall or winter periods.

Planning replacements for laying flocks. A purchased lot of unsexed chicks usually average 50 per cent cockerels and 50 per cent pullets. Statistics show that an average of from 5 to 25 per cent of the chicks die during the first three or four months of brooding and frequently a few runts need to be culled. Some of this loss may be reduced in most cases by using the

best brooding practices and by purchasing better quality chicks.

In addition to the chicks that die there may be a few cull pullets. To have the desired number of pullets in the fall, it is advisable to buy about 250 unsexed chicks for each 100 good pullets to be housed; about 125 sexed pullet chicks are required.

Number of pullets to replace old hens. The number of pullets required to keep a laying flock replaced depends on (1) the amount of culling and (2) the number of layers that die. The number culled will depend upon the quality of the birds and the care which they have received. This varies from 25 to 60 per cent. The mortality in the laying flock varies from 10 to 50 per cent. This, like culling, will vary greatly with the quality of the birds and the management of the flock.

Proportion of pullets to hens in laying flock. Studies of poultry farm businesses in New York, where the stock was mostly White Leghorns, show that pullets of good quality are usually more profitable as layers than are yearlings and two-year-old hens. This is in line with similar results elsewhere; consequently, about 60 per cent of a White Leghorn flock should be pullets. In New England, where New Hampshires and Rhode Island Reds are the principal breeds kept, it is common practice to dispose of all the old birds except a few for breeding each year. This procedure is justified because of the difference in value of the carcass at the end of the laying year, and the fact that the heavier breeds lay less eggs the second year relatively than do White Leghorns.

The cost of each replacement pullet is about the same except that the White Leghorns consume a few less pounds of feed before they begin to lay.

Rearing range. The kind of soil best adapted for growing chickens is a sandy or gravelly loam that can be cultivated easily. The land should always be in sod when the chickens use it.

Good pasture reduces the cost of growing pullets from 10 to 15 per cent. One of the secrets of having a good pasture or range is to cut it frequently and not to overstock it. Under

Fig. 55. Colony brooder houses located on good grass pasture. Note range shade A, *feeder* B *and waterer* C.

average seasonal conditions, one acre of good pasture provides ample green feed for 600 growing pullets.

The following seed mixtures have given good results in most sections of New York State and on many different types of soil. Similar mixtures may be obtained from any of the state colleges of agriculture and is advisable since some plants grow better in one region than another.

1. 12 pounds of Kentucky bluegrass
   6 pounds of perennial ryegrass
   2 pounds of Ladino clover
2. Six pounds of roughstalk meadow grass may take the place of 6 pounds of the Kentucky bluegrass when the seed is available at a reasonable price.
3. Two pounds of wild white clover may be substituted for the 2 pounds of Ladino, but wild white clover is less productive on soils that do not hold moisture and during seasons of low rainfall.
4. Straight seedings of Ladino clover up to 4 pounds to the acre have given excellent results.

The mixtures are planted at the rate of 20 pounds to the acre, and seedings are usually made without a nurse crop. In-

formation on cultural methods may be obtained from the county agricultural agent, or from the Department of Agronomy of any of the state colleges of agriculture.

The range should be within sight of the farm house and not too far from other farm buildings. Where this is not possible, arrangements are often made for a man to sleep on the range at night. It is unwise to have a range along a well-traveled highway, unless there is a fence to prevent the chickens from running onto the road, for many may be killed by passing automobiles.

Drainage and shade. Ranges on wet, poorly drained soil or in dense shade are poor investments, for coccidiosis organisms and roundworm eggs thrive best under such conditions. Shady places also harbor slugs and certain insects that are the carriers of tapeworm infection. Natural shade is desirable, but it should not be so dense as to prevent the sun from shining on the ground for quite a period at some time during the day. Artificial shade should be provided if no other shade is available.

REARING CHICKENS WITH HENS

When only a few chickens are raised, the simplest and easiest way is to brood them with hens. (See page 123.)

When the weather is cold, an average-sized hen can brood from fifteen to eighteen chickens, but in warm weather the same hen can brood from twenty to twenty-five chickens.

A roomy well-ventilated rain-proof coop with a detachable floor covered with shavings or sand should be provided. A floor prevents losses from rats, weasels and skunks, provided the front is covered with a fine wire screen at night. It also makes it easy to keep the coop sanitary. It is the best practice to keep the hen housed while the chickens run.

When a hen is given chickens other than those which she has hatched herself, she may not accept them, especially if

they are not the same color. Generally, the best plan is to put the chickens under the hen after dark. If she does not accept them then, another hen must be tried.

The hen must be dusted with sodium fluoride before the chicks hatch to prevent trouble with body-lice. It is not advisable to treat the hen for lice while she is brooding as there is danger of the chickens getting the disinfectant in their eyes. If the chickens become lousy, their necks may be greased with a small amount of lard. If the coop is old, one should be sure that it is not infested with red-mites from the previous season. Before using the coop, it should be sprayed thoroughly with a mixture of equal parts of crude carbolic acid and kerosene and occasionally afterwards.

As soon as the hen and chicks arrive in the brood-coop, the hen must be given a good feed of whole corn and milk or water placed where both hen and chicks can reach it. The chickens should be fed the regular food on a wide board just outside the coop.

Ordinarily in warm weather the chickens may be "weaned" when they are a month or six weeks old. The hen can then be returned to the laying pen.

ARTIFICIAL BROODERS

There are many different kinds and types of brooders on the market today. They vary considerably in size, from small individual movable brooders with a capacity for fifty to sixty chicks, to large permanent brooders capable of caring for thousands of chickens.

The essentials for a good brooder are—maintenance of proper warmth, sufficient ventilation, ease of cleaning, and economy of fuel consumption.

The type of brooder and heat used depends largely on the number of chickens to be raised, the season of the year, and the climate where the chickens are brooded.

THE SMALL BROODER

Where less than 200 chickens are to be brooded, and it cannot be done with hens, small electric hovers, or "fireless" or

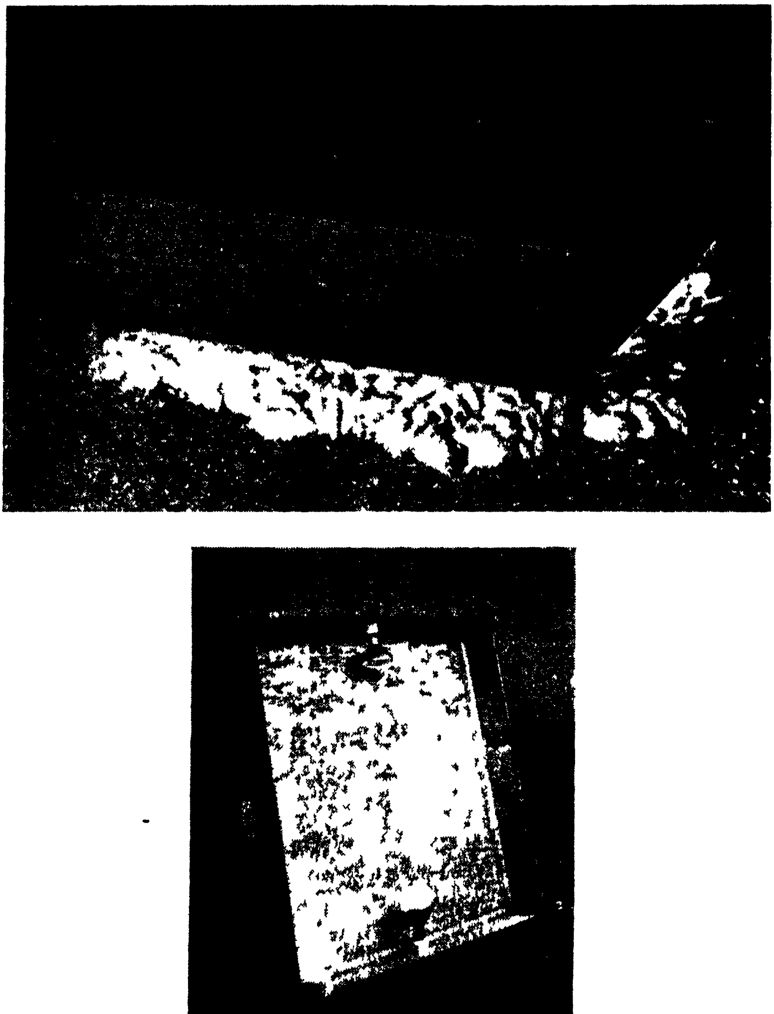


Fig 56 A brooder heated by electric bulbs. (Ohio State University)

unheated hovers may be used. Brooders heated by oil lamps are used but are not very satisfactory as they may not supply sufficient heat in the coldest weather and the danger from fire is considerable.

The Ohio Agricultural Experiment Station reports the successful use of brooder hovers heated by electric bulbs (Fig. 56). This method is often used in brooding lots of 25 chicks in the home. Light bulbs are placed in a chick box, or similar box. The size of the bulbs is varied with the heat requirements of the chicks and, of course, sufficient holes are made in the box to provide ventilation. A small door near the floor on one side permits the chicks to come and go.

Similarly a small number of chicks may be brooded in a paper or wooden box without heat if the brooding is done in the kitchen, or some other comfortable place. Strips of canton flannel may be suspended from a frame all over the inside of the box so that the chicks can snuggle up to each other among the ends of cloth. The top of the box is covered with cloth to permit a slow circulation of air. A hole is cut on one side of the box near the floor for the chicks to enter.

The ventilation of small brooders, as well as large ones, should have careful consideration. Chickens, on account of their high body temperature and rapid respiration need a maximum amount of oxygen. For this reason, close confinement in poorly ventilated quarters soon affects their vitality, retards their growth and increases the death rate.

BROODER HOUSES AND SYSTEMS OF BROODING

The colony system of brooding chickens is most common in the United States and is probably the least expensive. It is best adapted to farms where less than 2,000 chicks are to be brooded. Where more than this number are reared, a permanent brooder house supplemented with batteries and range shelters makes the most efficient method of handling growing chickens.

Permanent brooder houses. Units of a one story shed-roof type of laying house can be used as a permanent brooder. It is advisable, however, to insulate the building with some form of composition board or lumber to give better protection against temperature changes. The rafter plan of ventilation can be used.

In a permanent building 20 feet wide and varying lengths, partitions should be built to divide the room into pens 10 by 20 feet. Every other partition should be of solid material, to permit different temperatures in different pens according to the age of the chicks. No alleyways are needed.

The permanent brooder house is well adapted for the growing of winter broilers, and may be used also as extra quarters for the transfer of some of the laying stock during the late spring, summer, and fall months. By this plan the regular laying houses are vacated early in the season so that early laying pullets can be housed when they begin to lay without interfering with the hens in any way.

Many poultrymen are installing hot-water heating systems in permanent brooder houses, and in some homemade outfits house radiators are used in each pen as a source of heat. The radiators are placed horizontal to the floor and are covered with an asbestos-lined wooden hover. The hovers are usually placed near the rear of the pen but far enough from the rear wall so that the chicks will not suffer from the heat at any time. Homemade hot-water systems, such as those just described, are as successful, when properly installed, as patented outfits, and often are much cheaper. Any one not familiar with plumbing and the set-up of heaters should consult his local dealer in such supplies. Of course, coal and oil stoves or electric hovers work well in such pens.

As previously stated, some poultrymen are using a permanent brooder house with a colony system. The chicks are started in the large house and, when old enough to go without heat, they are moved to colony houses or cheaply constructed

buildings known as *range shelters*. This plan makes it easy to care for the chicks when they are small and gives them the advantages of free range when they are finishing their growth.

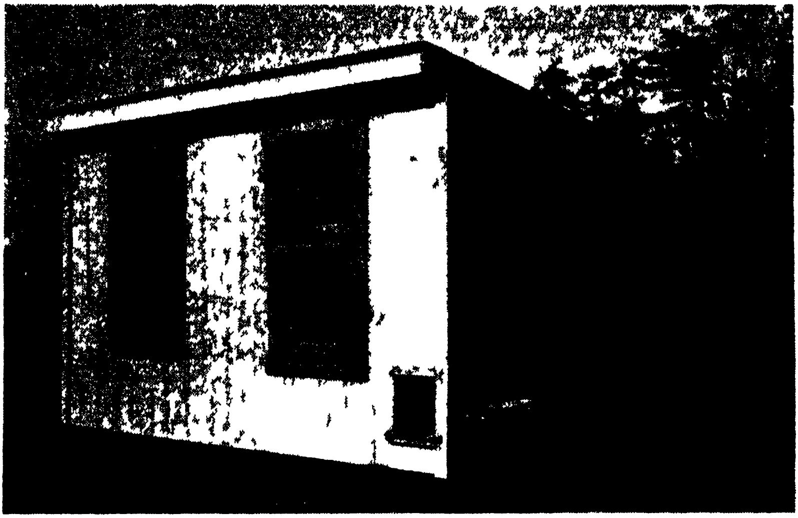


Fig. 57. A portable brooder house. Note the rafter ventilator in front and the sliding windows. There is a ventilator in the rear similar to the one in front.

Many poultrymen are meeting the problem of contaminated soil, which arises when this type of building is used, by providing a cement or wire-covered yard about equal in area to the floor space inside. Although this confinement method of rearing chickens is not so good as free range, ordinarily it is better than taking chances with the soil when it once becomes thoroughly contaminated and big losses result regularly

The larger brooder house can be arranged to contain a specially constructed room for battery brooding if this form of brooding is desired.

Colony brooder house. The most common size of a portable colony brooder house is 10 by 12 feet (Fig. 57). The roof may be the combination, gable or the shed type. The shed-roof house is easiest to build and ventilate. Any such building should be

constructed strong enough to withstand rough handling and frequent moving. The convenience of the caretaker must be considered. Good light and ventilation are essential for health

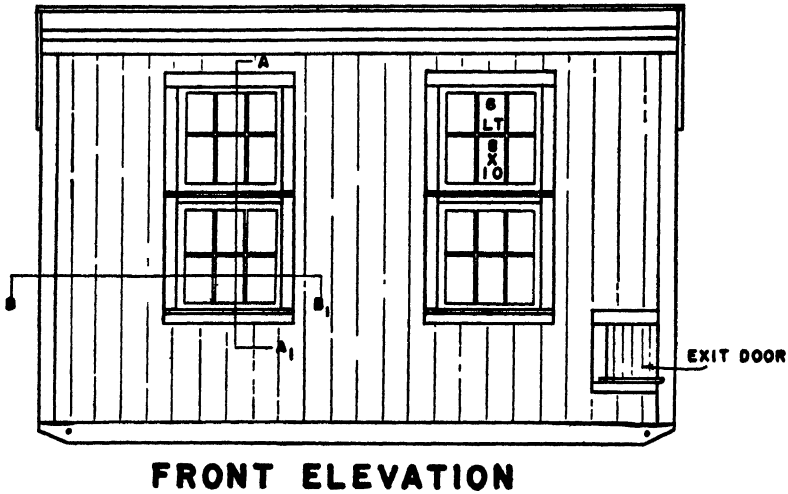


Fig. 58. Front elevation of the colony brooder house. The details of A-A′ and B-B′ are shown in Fig. 62.

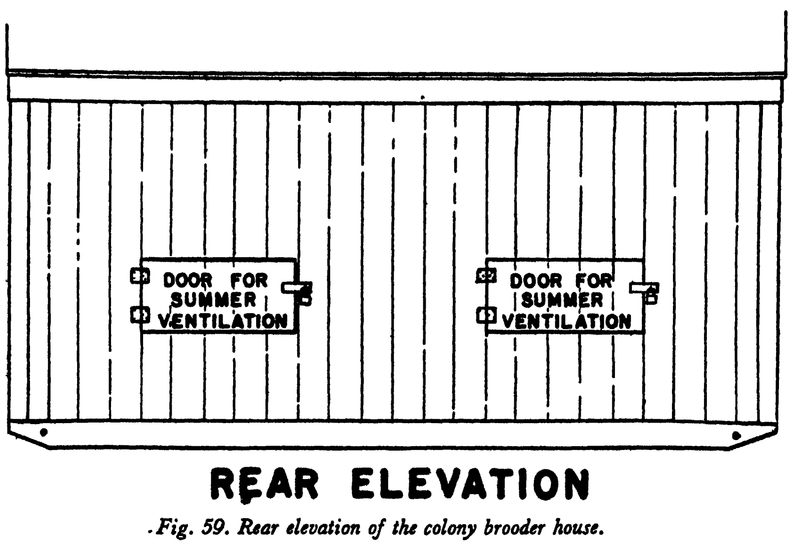


Fig. 59. Rear elevation of the colony brooder house.

and comfort of the chicks. A brooder house, designed to meet these requirements, is shown in Fig. 57, and the construction details are given in Figs. 58 to 65. This house is built on skids and is well braced so that it can be moved easily and often without racking it out of shape. The roof is moderately high

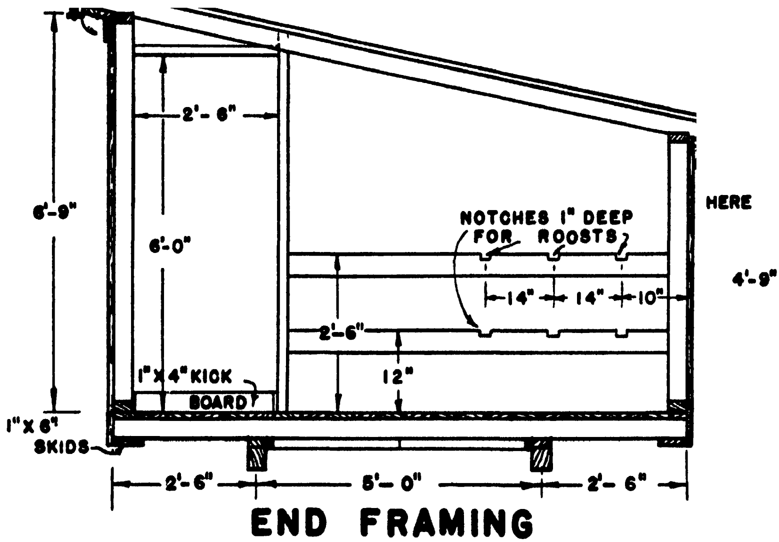


Fig. 60. Details of the east-end framing of the colony brooder house.

and the building is large enough for a person to work inside in comfort.

Ventilation. The windows are high in front, assuring plenty of light. The upper windows are arranged so that they slide to the right or left. A horizontal baffle board on the inside on one side of each window (Fig. 65) permits air to come in and go out when only a small amount of ventilation, with no drafts, is needed. The special opening under the projection of the roof, both front and back, is used in hot weather (Figs. 60 and 64). The front ventilator is opened by releasing buttons. If preferred, a rope and two pulleys may be arranged for closing the ventilator from the inside. In addition to these rafter venti-

lators there are two large openings near the floor in the rear of the house for use during hot weather.

Perches. Perches are used at two different levels, the first

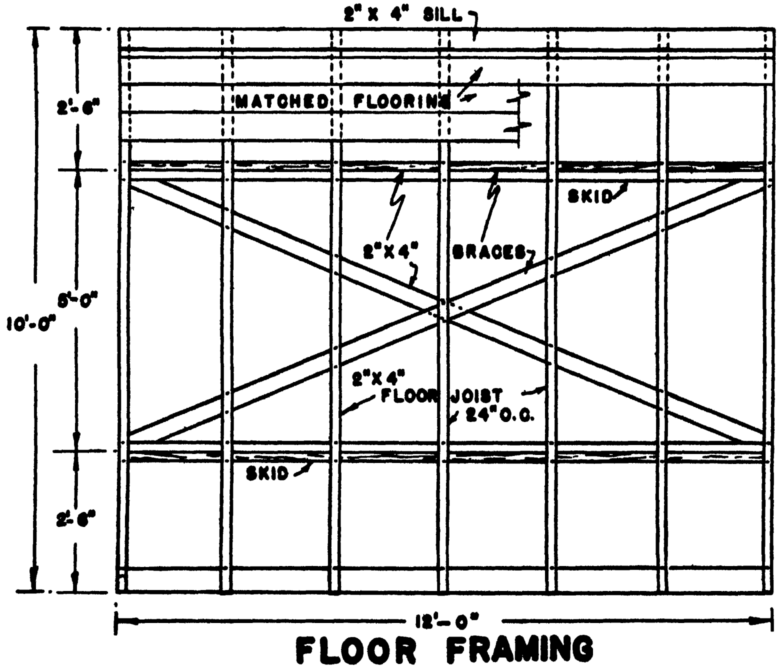


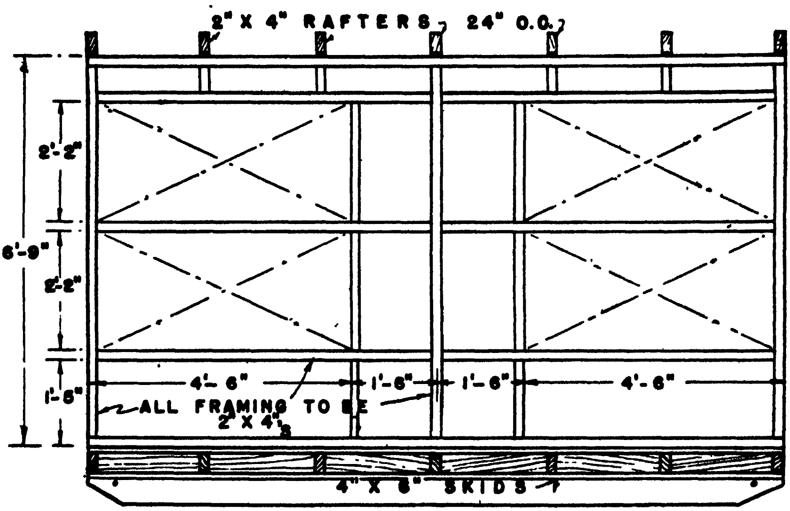
Fig. 61. The floor plan of the colony brooder house. Note the bracing of the runners to prevent racking.

at 12 inches and the second at 30 inches from the floor. The roosts are placed upon 1-inch notches cut in the 2-by-3-inch cross-pieces at the ends of the building (Fig. 60).

Exits. The door is on the right end (east side) of the building (Fig. 60). There is a small exit door for the chickens in the front near the floor on the right (Fig. 58), two in the rear (Figs. 59 and 63).

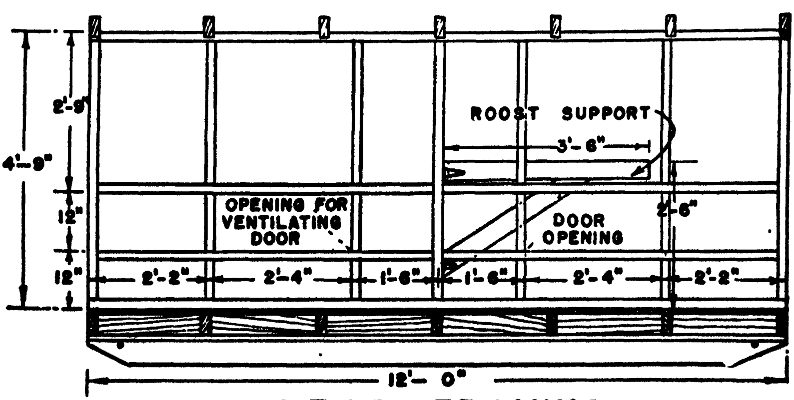
Care of runners. For convenience in hitching onto the house when moving it, large clevises, with ½-inch bolts that can be slipped through the holes at the ends of the runners, are

used. To prevent the runners from decaying rapidly and from freezing to the ground in cold weather, some short pieces of plank or flat stones should be used to block the runners 1 or 2 inches above the ground. The house should be level when in use.



FRONT FRAMING

Fig. 62. Details of the front framing of the colony brooder house.



REAR FRAMING

Fig. 63. Details of the rear framing of the colony brooder house.

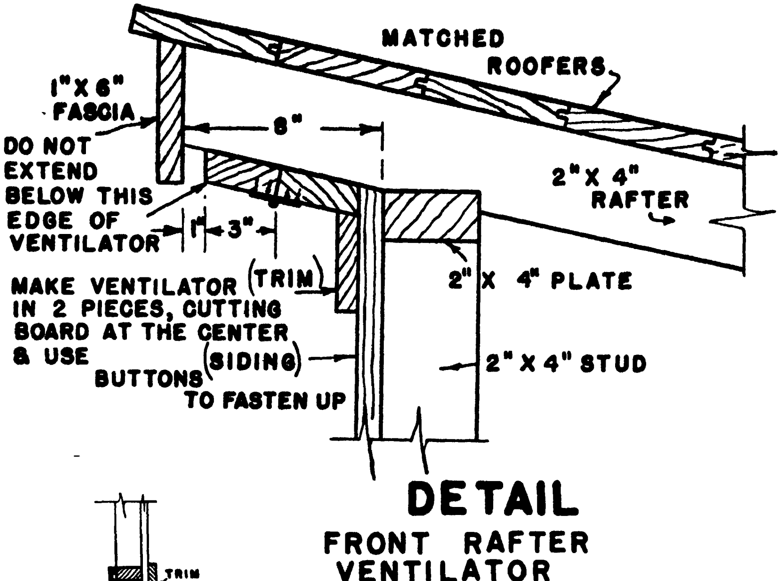


Fig. 64. Details of the front A ventilator.

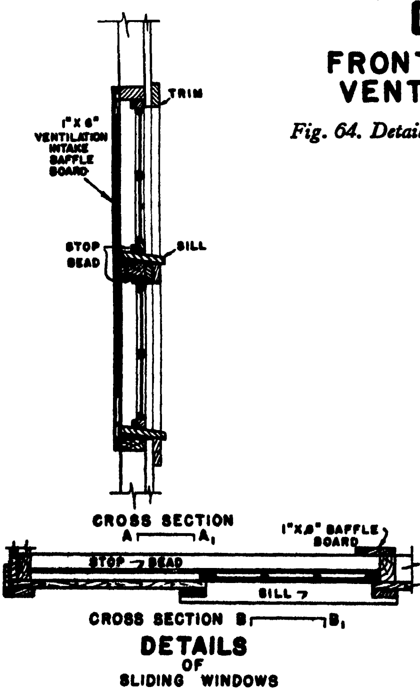


Fig. 65. Details of the sliding windows and the ventilation intake baffle board.

Portable two-room brooder house. A few poultrymen use a two-room portable brooder house. This consists of a building 2 feet longer than the house described in the preceding paragraphs and is built with a removable partition. This arrangement provides a small room to heat, requires less fuel, gives the chicks a chance to exercise in cool air without going outdoors, and lessens the danger of floor drafts.

RANGE SHELTERS

In recent years range shelters have come into general use on poultry farms in most parts of the United States. They are an inexpensive supplement to the regular poultry housing equipment.

Fig. 66. A range shelter.

Range shelters are most desirable on poultry farms to shelter the birds from the time they are removed from permanent brooder houses, battery brooders, or overcrowded colony houses, until they are ready for the laying house. Since in recent years there is an increasing tendency to hatch chickens for replacement earlier in the season, this type of building seems to have increasing value. The chickens are transferred to the shelters when they are well feathered and are able to do without heat. This usually is possible about the first of May.

There are many types of range shelters. Most of them have a gable roof and wire-covered sides about two feet high. The floors also are covered with 1 x 3 or 1 x 4 inch welded wire. Practically the entire inside space is used for roosting quarters.

In some instances the shelters have been constructed with over-hanging roofs so that the feed troughs may be placed along the sides of the house under the roof. When this is done,

laths are used in place of wire on the sides. This permits the birds to use the feed troughs from the inside as well as the outside.

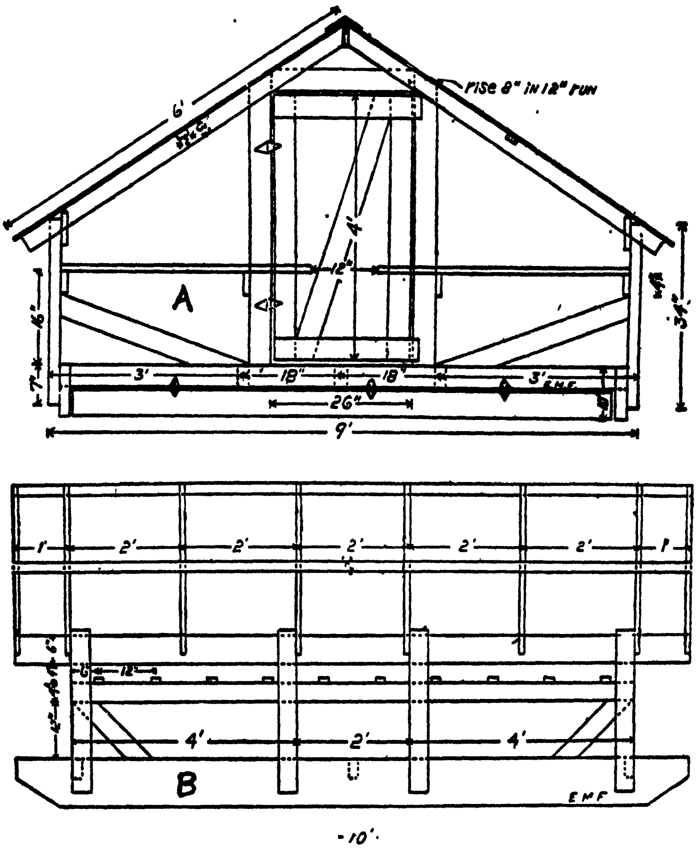


Fig. 67. Dimensions and plans for the range shelter shown in Fig. 66.

In less expensive types of shelters no floor covering is provided. To give more protection in early spring, sacks are often tacked over the sides and ends.

In New England a new type of range shelter has been developed in which movable panels are supplied for the ends and sides. This permits their use in early spring. Later in the season

these panels are opened or removed. Such houses may have dirt floors. These houses are used for laying hens during the summer.

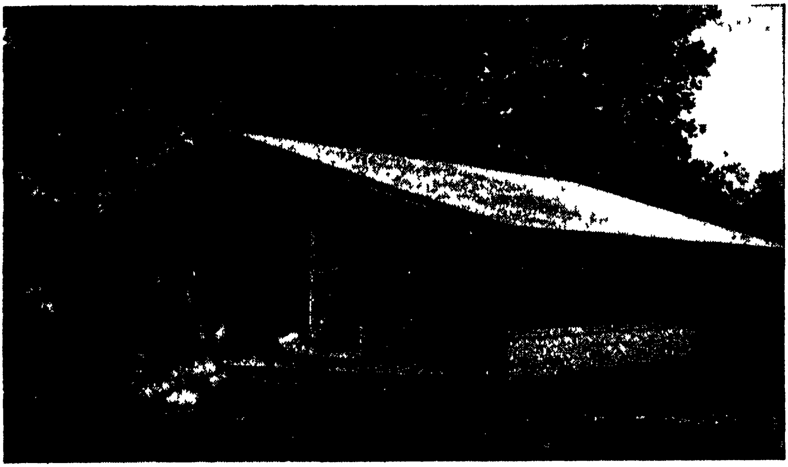


Fig. 68. A summer shelter for laying hens. This shelter has a dirt floor. The Connecticut All-Season 24′ x 24′ Laying Shelter with adjustable sides is designed to meet the needs of the ordinary summer laying shelter plus protection early in the spring and late fall for young stock, laying hens or surplus males. (Courtesy of Roy E. Jones, University of Connecticut.)

BROODING EQUIPMENT

The right kind of brooding equipment is important in growing paying pullets.

Of all the equipment, the heating outfit should be given first consideration. Five sources of heat may be considered for movable colony brooder houses: coal, oil, electricity, gas, and wood. All five may be used in permanent brooder houses. In most instances, however, a hot-water system with a central heating unit is used in permanent brooder houses. Either coal or oil is used as fuel for such a system.

The coal-stove heater for colony brooder houses. In a large part of the United States coal-burning brooder stoves are dependable and satisfactory. They furnish an ample supply of heat with low cost of fuel. They are comparatively safe from fire and

fairly easy to operate. When an abundance of heat is needed in early spring brooding, coal brooders are best.

In selecting a coal-burning brooder stove, one should look for a good-sized, oval-shaped, fire-box, a good grate (preferably rocker) that will not clog with clinkers, and a sensitive

Fig. 69. Coal-burning brooder stoves. The heat deflectors on most coal stoves are in two parts.

draft regulation (Fig. 69). Usually the type of regulator that controls the lower draft as well as the upper check draft at the same time is best.

The manufacturers greatly overrate the capacity of coal brooder stoves. If chickens are to be brooded in very cold weather, it is advisable to buy the largest sized stove, as it furnishes more heat and holds a fire better than does a smaller stove.

If a coal stove is used, the brooder house should be so placed that trees, buildings, or knolls do not interfere with the draft. It is usually good practice to have the stovepipe 3 feet higher

than the roof of the building. If draft is still poor, the pipe should be lengthened. When there is too much draft, the pipe may be shortened.

Back drafts can be prevented by having a cap 3 or 4 inches above the end of the pipe. A metal holder in the roof where the stovepipe passes through prevents water from entering and lessens the danger from fire. *The pipe should be taken down once a week and the soot cleaned out.* A damper in the pipe is not necessary, but an automatic draft equalizer is desirable to maintain an even fire in windy weather. Chestnut-sized anthracite coal makes the best fuel for brooder stoves.

Oil-burning brooder stoves. Oil brooder stoves are of two types; the wick burner and the blast type of burner. The principal difference is in the burners. The wick burner usually burns kerosene and the flame is raised and lowered by hand. This burner maintains a constant flame, but the hover temperature is regulated by a ventilating flue and damper operated by a thermostat. The wick burners cannot be depended upon to supply enough heat for winter brooding.

The blast type of burner uses either kerosene or fuel oil and has an asbestos or metal ring which acts as a vaporizer. The temperature is regulated by a thermostat which controls the flow of oil to the burner. This type of burner is used satisfactorily in winter brooding. The drum type uses from 2½ to 3 times as much fuel as the wick type, but will accommodate many more chickens.

Both types of burners are fed from a barrel or tank of oil either in or outside the house. Kerosene burners must be set level to operate best. They require careful attention. Daily cleaning of the wicks is necessary to remove soot and to prevent clogging. Sand is recommended under the hover as a safety measure.

Although some wick type burners have curtains for the hover, they should be used with care. The other types usually operate without them. No attempt should be made to operate

oil-burning stoves where there is a draft. Only the best grade of fuel should be used.

The drum type of oil-burning stove is often equipped with a heat deflector instead of a hover. The drum stove should have a good cast-iron fire pot and spreader. The supply pipes should be direct and easy to clean; and have a strainer and sediment trap. The oil should flow through a visible drip filter with good cast valves and regulator arms. An efficient thermostat control is a necessity on the burner.

The blast-burner oil stoves should have an overflow pipe, and this should be properly connected and installed before the stove is operated.

A good system of ventilation is essential both for the stoves and the chicks. Without it there is sure to be trouble.

While the original cost of an oil brooder stove may be lower than for some other kinds of brooders, the cost of fuel may be somewhat higher. The chief advantage of oil brooders is in warm weather when little extra heat is needed. On such occasions it is easy to regulate the size of flame to supply the amount of heat desired.

Gas stoves. Gas works very well as a fuel for brooder stoves where it is available. Stoves suitable for burning gas may be purchased from stove manufacturers or gas burners may be bought and adapted for either coal or oil-burning stoves. It is usually advisable to have a thermostat to prevent variations in pressure and to maintain an even temperature. A vent for the fumes and ample ventilation should be provided day and night. Gas is not so practical as other fuel for brooder houses on range as it requires considerable pipe and labor to change from one field to another.

Bottled gas is used successfully by a few poultrymen. Because it is portable, it is easier to handle on the range than piped gas or electricity. The brooding cost of bottled gas compares favorably with the cost of other fuels and electricity.

Electric brooders. With the increase in distribution of power

lines, cheaper power rates, and improved equipment, the electric brooder is coming into general use.

Certainly the advantages of freedom from danger or fire, the complete control of the temperature under the hover at all times, and the saving in labor make this method of brooding chicks attractive. One of the disadvantages of electrically heated hovers is the fact that there is no surplus heat for the brooder room. Not only is this uncomfortable for the operator but it is likely to result in damp litter in cold weather, especially if enough ventilation is not provided. The coldness of the room may also prevent the baby chicks from coming out to eat at first. It may be necessary to provide electric water warmers for the drinking water to prevent its freezing, or to use small fountains that may be placed wholly or partially under the hover. Another disadvantage, of course, is the possibility of a power interruption due to storms, and the like.

Fig. 70. An electric brooder. (Empire State Gas and Electric Corp.)

The best types of electric hovers have a curtain around the hover and from ½- to ¾-inch thickness of insulation board, or its equivalent, to save heat and power. In some hovers the insulation is placed in a sheet just above the chicks' backs, with a large air space in the cone of the hover above. Other brooders have the insulation, either board or wool, placed on the underside of the sloping hover. Either method is satisfactory if the insulating value is adequate.

According to the Department of Agricultural Engineering at Cornell University: "The 'black heat' element, which does not

become red when in operation is the more durable and produces less fire hazard than the 'glow heat' type. 'Black heat' elements, either wire coils or strip heaters, are used in many brooders and either type is satisfactory."

Fig. 71. A home-made electric brooder. The brooder unit, purchased without the hover, contains the thermostatically controlled heater coil, electric ventilation fan, pilot, and attraction lights in one assembly. Instructions for building the hover comes with each brooder unit. *The hover is made of wood and is insulated with wood shavings.*

The home-made electric brooder shown is 4 feet square and has a capacity of 300 chicks. The brooder unit is lying on the shavings on top of the hover, but in operation it hangs from the opening in the center of the hover. Other sizes of brooder units are available for smaller brooders.

"In brooders with 2,000 to 3,000 square inches of floor area, the heating element should be no less than 550 or 575 watts and need not be more than 750 or 800 watts. Lower wattage than this may be insufficient for the low temperatures experienced in winter brooding, and extremely high-wattage heating elements may use an excessive amount of current."

Ventilation of electric brooders is accomplished by either of two methods of producing air movement: (1) forced ventila-

tion, by means of a small electric fan, and (2) gravity. Both methods of ventilation are successful in operation.

For better insulation and comfort a board platform of 1-inch boards is recommended under the hover. This is particularly important in winter brooding.

Portable units which include the heating element, fan, pilot-light, and the like, are now available for any one who wishes to make the hover at home. This reduces the cost of the brooder.

The amount of hover space is important and varies with different kinds of poultry. For cold-weather brooding, the capacity of the brooder should be determined by allowing at least 10 square inches of floor area per chick under the hover for breeds such as Leghorns; 12 square inches for breeds such as Barred Plymouth Rocks; 12 square inches for ducks; and 20 square inches for turkeys. Because the heat in a good electric hover is confined to the hover by insulation and a curtain, such hovers must not be overstocked. Later in the brooding season, after outside temperatures are higher, the floor area per chick may be decreased slightly.

Repeated tests show that enough heat is provided under the hover in the coldest weather if the hover is properly constructed and insulated. This removes one possible objection to this method of brooding chicks.

If the cost of power is less than 3 cents a kilowatt hour, the cost of operation is likely to be equal to and often less than that for coal brooders, and less than for oil-burning stoves. Comparative costs are given in Tables XVIII and XIX.

Woodburning brooders. Wood-burning brooder stoves are used in many parts of the United States. The operation of these stoves is similar to that of a charcoal oven; the wood is burned slowly by restricting the draft. The draft damper is controlled by a thermostat. It is important that these wood stoves be of air-tight construction with close-fitting doors and tight-closing and accurate dampers to prevent air leakage, which would

interfere with the draft control. The fuel door should be large enough to take big chunks. The smoke pipe should run straight up from the stove and be properly insulated where it goes through the roof to prevent fire hazards. Proper precaution should also be taken to prevent accumulations of creosote. Stoves should be selected that are well braced and rigid if safety and long use are desired. Wood stoves may prove to be very economical on farms where wood is available. Almost any kind of wood may be used.

A comparison of brooding costs in winter and spring. A comparison of costs for brooding chickens where different sources of heat are used is given in Tables XVIII and XIX. This work was carried on cooperatively by the Department of Poultry

TABLE XVIII

A Comparison of Brooder Costs per Chick in Winter with Different Sources of Heat

(250 chicks, January 4 to March 2, 1935, 8 weeks)

Costs	Gas	Oil	Coal	Electricity, Cold House *	Electricity, Warm House †
	Cents	*Cents*	*Cents*	*Cents*	*Cents*
Feed	0.141	0.137	0.139	0.124	0.133
Fuel	0.043	0.059	0.031	0.030	0.023
Shavings	0.019	0.017	0.017	0.023	0.021
Labor	0.053	0.059	0.072	0.057	0.054
Chicks	0.120	0.120	0.120	0.120	0.120
Total	0.376	0.392	0.379	0.354	0.351
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Mortality	0.8	2.8	2.8	3.2	1.2

* A cold house had no heat other than that under the hover.
† A warm house was heated by electric power thermostatically controlled at 60° F.

Husbandry and the Department of Agricultural Engineering at Cornell University. Two hundred and fifty chickens were brooded in shed-type brooder houses 10 by 12 feet in size. The brooder costs were: labor, 35 cents an hour; shavings, $15 a ton; feed, $50 a ton; oil, 8.5 cents a gallon; gas, 7 cents a

therm (100 cubic feet, B. T. U. per 1,000); electricity, 2 cents per kilowatt hour; coal, $12.50 a ton.

In general, the figures in Tables XVIII and XIX show that it

TABLE XIX

A COMPARISON OF COSTS PER CHICK IN SPRING WITH DIFFERENT SOURCES OF HEAT
(250 chicks, March 8 to May 3, 1935, 8 weeks)

COSTS	GAS	OIL	COAL	ELECTRICITY, COLD HOUSE *	ELECTRICITY, WARM HOUSE †
	Cents	*Cents*	*Cents*	*Cents*	*Cents*
Feed	0.131	0.125	0.120	0.120	0.118
Fuel	0.017	0.039	0.024	0.024	0.015
Shavings	0.015	0.012	0.013	0.017	0.015
Labor	0.039	0.045	0.055	0.042	0.041
Chicks	0.120	0.120	0.120	0.120	0.120
Total	0.322	0.341	0.332	0.323	0.309
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Mortality	9.4 ‡	0.8	3.2	2.8	5.2

* A cold house had no heat other than that under the hover.
† A warm house was heated by electric power thermostatically controlled at 60° F.
‡ This mortality is not due to the equipment.

costs less to brood chickens in spring than in winter under the conditions cited in these trials.

HOW TO PREVENT STEALING

Chicken stealing is very common in some sections. Nothing is more discouraging or exasperating, after a poultryman has spent time and money in growing a fine flock of chickens, than to have them stolen. Often it is impossible to replace the quality of birds taken, therefore some thought should be given to guarding against theft.

First of all, the brooder-houses should not be situated where they are readily accessible from a highway and they should be locked securely with a strong padlock every night. Lack of such precautions invites stealing.

A good dog running at large or chained near the brooders will keep many intruders away.

Tattooing is the most recent method of preventing stealing. A number is tattooed in the web of the wing of each bird.

A special electric alarm system arranged so that the doors and windows cannot be opened without ringing a bell in the bedroom of the owner will have some value in stopping thieves.

In a few counties and communities protective associations are of some assistance in preventing stealing.

Lastly, when it is known that certain precautions are in force, thieves are not as likely to take chances.

IX. Brooding, Feeding and Rearing Chickens

THE main object in brooding chickens is to secure uniform rapid growth. To do this conditions must be favorable, the food the best and the brooding carefully executed.

THE BROODER HOUSE AND EQUIPMENT

Old houses should be cleaned and disinfected and new ones made ready a few days before the chickens are expected. Detailed plans for new houses are discussed on pages 142 and 147.

Cleaning. The best way to clean a brooder house is to remove all roosts, fixtures, and equipment, to sweep down all dust and cobwebs, to wash the windows, and to clean the floor by scraping off all dried material. The floors and about 1 foot of the adjoining side walls should be scrubbed with a strong

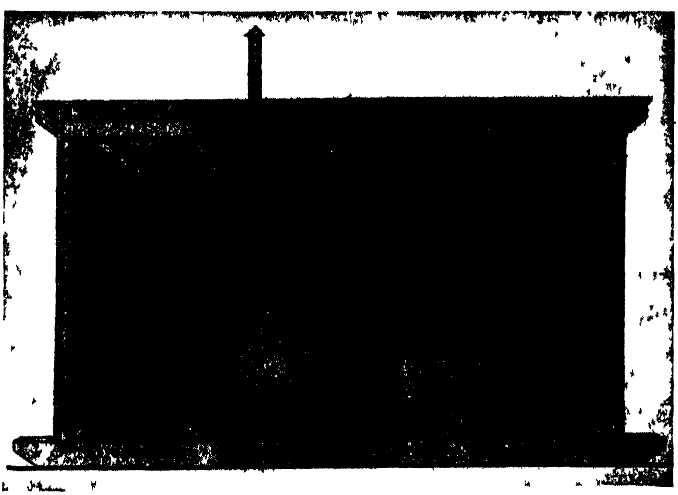


Fig. 72. A colony brooder-house ready for the chicks. Note the chick-guards and fountains, and the position of the stove on one side of the room for greater convenience.

solution of hot lye. About 3 ounces of household lye to each gallon of water; boiling hot water is best. Care should be taken not to get the solution on any part of the body. The solution should be applied with a stiff broom. The ceiling and unwashed walls may then be sprayed with a 3 per cent solution of cresol disinfectant. Such a solution is made by mixing 3 ounces (½ pint) of the disinfectant with one gallon of water.

The floor should be flooded with the cresol solution. Feed troughs, drinking vessels, hovers, and other equipment should be washed with the cresol solution or a similar disinfectant. It is good practice to have an old oil barrel or tank filled with the cresol solution in which to disinfect such equipment.

Overhauling heaters. The heating apparatus should be overhauled and placed in first-class working order a few days before the chickens are due. By this practice the houses are made warm, dry, and comfortable for the chickens when they arrive.

Litter. Shavings, sugar-cane fiber, or finely cut straw make the best litter because they are clean, free from dust, easily removed and replaced, and generally cheaper than other litter.

It is important in disease control to keep the litter dry. Two or three inches of litter are enough at the start, but this should be increased later. When the chicks are 8 to 10 weeks old, the litter should be 4 or 5 inches deep. Deep litter must be stirred daily to keep it dry. Forking or raking it over once a day usually is necessary. Wet or packed-down litter around the watering fountain should be promptly replaced with fresh material or dry litter from other parts of the floor. Usually it is not necessary to replace the entire litter during the period of brooding unless it becomes damp, very dirty, or coccidiosis appears.

Floor space. Best results are obtained when the brooder house is not overcrowded. Not more than three chicks should be allowed to each square foot of floor space; two are preferable. It is not practical or advisable to run more than 500 or less than 250 chicks in one flock even though the floor space

would permit such a variation; 250 chicks to one house or pen makes an ideal unit. Sexed pullet chicks, must be given more room at about 6 weeks of age or serious crowding will result.

Each eight-weeks-old pullet should have not less than 1 foot of floor space; birds in confinement need 2 feet. Otherwise, there may be considerable trouble from cannibalism and feather picking.

Hover space. The hover should be large enough to accommodate all the chicks at one time without crowding. Allowance should be made for the increase in the size of the chickens and the changes in weather conditions and season of the year. On cool nights when the room temperature is lower, the chickens will remain under the hover more than during the warmer nights of late spring.

Hover space varies with the type of brooder. For coal, oil, and gas-heated hovers, 7 square inches are needed for each chick; for electricity, 10 inches. Capacity in hoverless or deflector types of oil brooders is determined by the size of room and the heat unit.

Drinking fountains. Two-piece metal, earthenware, agate, or glass fountains are used. Usually one 1-gallon or two 1-quart fountains are enough for 100 chicks when they are small. Later on a 3- or 5-gallon fountain should be provided.

The desirable fountains have a drinking rim so designed that it is difficult for the chicks to get into the water and drown. In large permanent brooder houses, automatic water receptacles are desirable. New galvanized iron dishes should never be used for sour milk or buttermilk. The acid of the milk acts on the metal, sometimes making the milk poisonous to the chicks if it remains in the container for several hours.

Chick guards. A circle of ½-inch-mesh hardware cloth or some similar material 15 inches wide should be set up from 15 to 18 inches outside the brooder hover when the chicks are first placed in the brooder. If there is danger of floor drafts, boards

or building paper should be used. The size of this circle teaches the chicks to return to the brooder for warmth. After a day or two the guards should be enlarged to give more space, and later should be removed entirely.

Outside yards. The chicks should be kept busy at all times. This may be done by allowing them to run out-of-doors every day after they are five or six days old, when the weather and the season permit.

At first they should be confined to a small yard until they learn the way back into the house. Later these fences should be removed, and the chicks given free range.

The handiest fencing material is 1-inch-mesh chicken wire 2 feet wide. It should be carefully pegged to the ground, as young chickens are quick to find holes under it.

All openings under the brooder house should be blocked with 1-inch-mesh chicken wire.

The approach to the brooder house should be made of sods or a frame covered with ¾-inch hardware cloth, so that it is easy for the chickens to enter. This precaution may prevent losses from accidents.

STARTING THE CHICKENS

The first few days in the brooder are important in the life of chickens, for habits acquired then may have a serious effect on their future growth.

Brooder temperature. The temperature under the edge of the hover, 2 inches from the litter, should be from 95° to 100° F. the first week, from 90° to 95° the second week, and gradually lowered until no heat is needed. It is best to keep the temperature as low as possible and still have the chickens comfortable. The amount of heat and the length of time it is needed depend on the season and the day. However, the heater should be left in the brooder house a while after the heat is discontinued for possible use in unfavorable weather.

When the chicks spread out in a circle at night under the

inner edge of the hover, the temperature is correct. The temperature under the hover should never drop to the point where the chicks are uncomfortable. Chickens seem to feather better if the room is not kept too warm, or is just comfortable, and if they have an opportunity to exercise out-of-doors or in an adjoining room that is cool. However, enough heat should be provided under the hover in the daytime and at all times so that young chicks that become chilled can get warm quickly. Too high temperatures encourage cannibalism and sap the vitality of the chicks. Overheating or chilling causes a diarrhea and many deaths; when pullorum disease is present, chicks are more susceptible to it. It is important, therefore, to try to maintain as even a temperature under the hover as possible.

Crowding. Crowding at night is usually the result of chilling, overheating, drafts, or rays of light. The temperatures should be carefully watched the first few days. A chick guard should be used around the hover the first two or three days, and the space outside the hover made larger each day. Later, when the guard is removed, the corners of the pen should be blocked with straw, wire, or wide boards, to prevent possible crowding. The wire or boards must be so arranged that the chicks cannot jump down behind it after a few days. The operator should be on hand at roosting time, especially the first day the chicks are placed in the brooder. If the chickens crowd, they should be spread around the hover. If crowding persists, a 10-watt electric light or a lantern may be placed over the hover. Usually the light checks crowding. More than a 10-watt bulb makes the pen too light and increases the charge for power.

Ventilation of brooder house. When the chicks are small, it is usually advisable to keep the house air-tight on three sides and to see that there are no cracks in the floor. Provision should be made for an adjustable outlet or ventilator at the highest point in the room. An adjustable intake also should be provided. This is done in the shed-type house by regulating the

opening between the rafters in front and by sliding the front windows (see Fig. 57). Of course, the size of the opening is determined by the season, the outside temperature, and weather conditions. The ventilators should never be completely closed.

In the early spring there is usually a wide range in temperature from midday to midnight. It is important to be on the outlook for this and to enlarge the ventilator openings, possibly by taking out one or more front windows during the sunshiny warm day. It is necessary, of course, to close these extra openings at night. Rapid and extreme changes of temperature are unhealthy.

In hot weather it is advisable to keep the building as comfortable as possible by changing the air in the building frequently, but in such a way as to prevent drafts on the birds. This can be done by opening the rafter ventilators in the brooder house (see Fig. 57), both back and front, to the fullest extent and by removing the glass sash in the front of the house. Similar openings can be made in the front and at the highest point of any type of house.

Exercise. Healthy chickens are active. If they are not busy, something is decidedly wrong. The room temperature should be much lower than the hover to encourage better feathering and more exercise. A room temperature of from 50° to 60° F. is much more desirable than a higher one after the first week. Plenty of fresh air usually keeps the temperature down. Good ventilation is as important during the night as in the daytime.

From the time the chickens are four or five days old they should have an opportunity, if possible, to run out-of-doors. This gives them plenty of exercise and the necessary exposure to the direct rays of the sun, which helps to keep them healthy. They should pick their own green food.

It is not injurious for chickens to run out-of-doors in cold or ordinary wet weather, if they have a good warm hover handy when they feel the need for it. Usually, the chickens are

bothered less by wind when the runway hole is on the protected side of the house. In most locations the brooder house should face the south for maximum exposure to sunlight.

When it is necessary to rear the chickens entirely in confinement, well-ventilated, roomy quarters are an incentive to exercise.

Keep old and young stock separated. The brooder house should never be situated so that young and old stock mix on the range. If this is impossible, then it is best to yard the old birds or keep them confined to the house, so that the young stock may have the benefit of free range without the danger of contact with the older birds. Old stock is usually the principal source of infection for coccidiosis, respiratory diseases, worms, the avian leucosis complex (paralysis, iritis, big liver, and the like), and other diseases.

Eight years' results at the Ohio Agricultural Experimental Station and three years' work at the New York State Veterinary College show that chicks and growing pullets are highly susceptible to diseases present among older birds near where they are grown. Growing the pullets on a different farm from the old stock, where no poultry had been kept for several years, resulted in a decided drop in laying-house mortality as compared with stock raised on the home farm near old birds. At each experiment station both lots of chickens were hatched from the same breeding stock. These results indicate that better livability may be expected when the chickens are raised in isolation.

Cannibalism. (See Chapter XIX, page 498.)

Feeding practices. There are many successful rations and methods of feeding chickens. The method suggested here has been used successfully for many years.

Baby chicks should be given feed and water within thirty-six hours after they are hatched. Strong, well-hatched chicks can go without feeding up to sixty or seventy-two hours, but it is difficult for some chicks to stand the strain and some

may die. Consequently, it is not advisable for best results to withhold feed longer than thirty-six hours as the chickens lose weight and vitality rapidly after that time. Feed and water should be ready for the chicks when they are placed in the brooder to prevent their eating litter, droppings, or any other material that is handy.

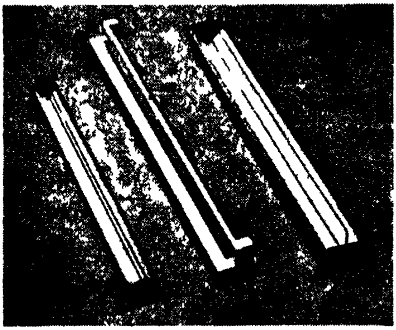


Fig. 73. Feeders for young chicks for the first few days.

Baby chicks should have feed easily accessible, and plenty of feeding space, so that they will learn to eat readily. Small trough feeders about 1 inch deep and 2 or 3 inches wide made of wood or metal may be used during the first few days (Fig. 73). Some poultrymen feed the mash and grit on papers, egg flats, or cardboard covers, the first day or so, particularly if they are short of feeders, to make sure all the chicks get something to eat. This latter practice is objectionable if pullorum disease is present, for the droppings from diseased chicks will become mixed with the feed.

After two or three days, when the chicks have learned to eat, larger trough feeders (Fig. 74) with wire guards or a reel to prevent the chicks from getting into feed are used. Such protected feeders help to check the waste of feed and tend to prevent the spread of disease by keeping the droppings out of the feed.

One inch of feeder space should be allowed for each chick up to two weeks of age, when the space should be increased to 2 inches.

Boards or planks along the sides of the feeder make it easier for the chicks to reach the feed during the first week. The feeders should be distributed around the hover so that all chicks have a chance to eat.

As soon as the chicks have learned to eat out of the feeders, both the feeders and fountains are placed on wire-covered platforms 6 inches high (Fig. 75). This places these containers

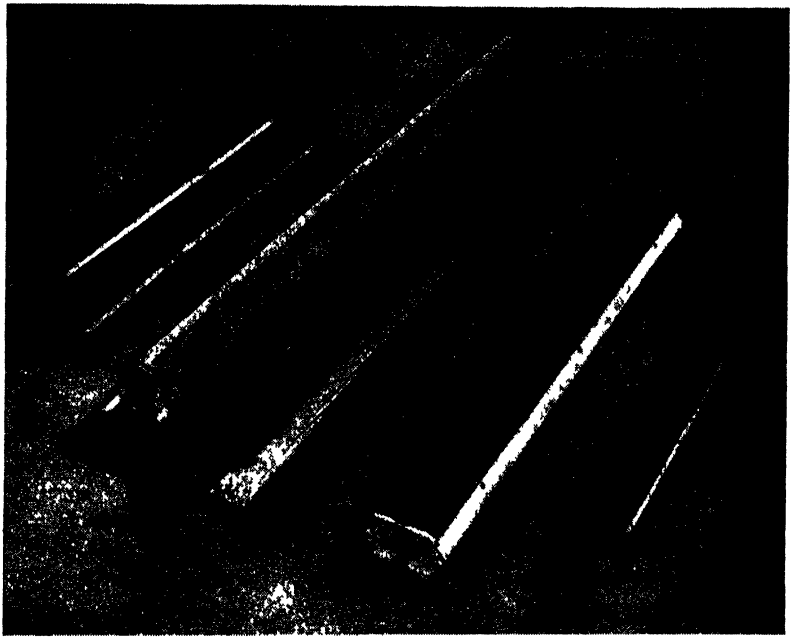


Fig. 74. Intermediate feeders for young chicks from one to eight weeks of age.

where litter cannot be easily scratched into them, and the chicks do not come in contact with the wet spots caused when water is spilled from the fountains. Neither do the chicks have an opportunity to consume feed thrown out of the feeders and contaminated by the droppings in the litter, for both the water and feed fall through the wire out of reach of the chicks. Three-fourths or 1-inch-mesh wire is used for the top of the platforms.

After eight or ten weeks of age, the smaller feeders should be discarded for larger feeders; and, if the birds have an outside range, most of the feeding may be done in properly pro-

tected outdoor feeders (Fig. 77). At least 1 linear foot of hopper space should be allowed for every 10 birds after they are 8 weeks old. One feeder in each brooder house, is useful on rainy days and when the birds have to be shut in.

Good chick mashes, such as the ones in Table XX, contain

Fig. 75. Wire or slat-covered frames for fountains. These frames confine the drip from the fountains and help to keep the pens sanitary.

about 20 per cent protein and may be fed during the entire rearing period. No grain is fed during the first month, with the possible exception of the first two days, when some poultrymen prefer to feed grain and no mash. The kind of feed a chick receives during the first few weeks of its life has an important bearing on its growth and development. This is particularly true if the chicks are grown in confinement. Normal chicks double their weight about every two weeks during the first six weeks of their lives. Later, as they approach maturity, growth is less rapid. The ration must contain all the food elements, but particularly the vitamins and 18 to 20 per cent of protein, if normal growth is to be made early in the life of the chicks. Because cereals alone are low in minerals, vitamins, and protein, mash must be depended upon to supply the proper levels of these elements. This is why all-mash feeding is recommended during the first month. At the end of this time when the protein

requirements of the chickens are less, grain feeding is started. The grain is fed in hoppers and kept before the birds con-

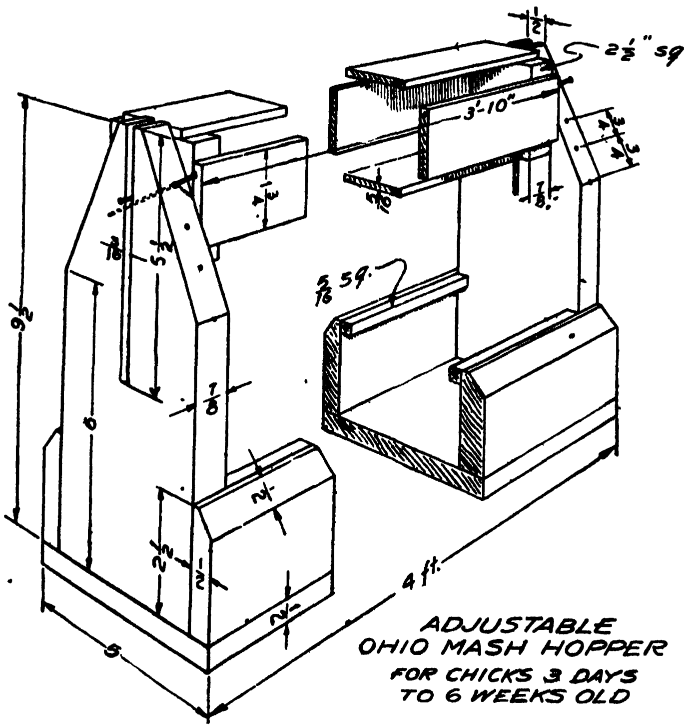


Fig. 76. A sanitary chick feeder.

stantly. However, the chickens should not eat so much grain by weight as mash until they are three months of age.

During the first few weeks, it is advisable to feed the mash in such amounts that it will be possible to give fresh mash twice daily. Later it is kept before the birds all the time. Occasionally it may be necessary to restrict the grain in order to get proper mash consumption. Considerable variation in grain consumption is permissible after the chicks are three months of age. A less expensive growing mash may replace the starting mash after the birds are 10 or 12 weeks old if they have access to good green pasture.

Fine, insoluble grit should be given from the start. A small amount is usually spread on the mash or mixed with the grain at the time of the first feeding. Later it is kept in separate

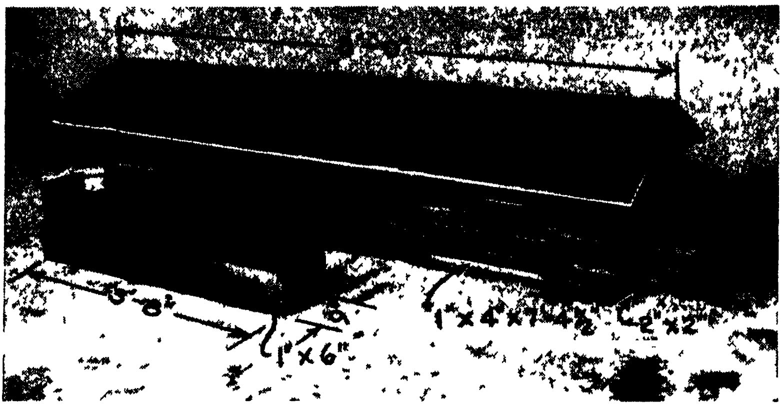


Fig. 77. The Cornell outdoor range feeder. This feeder is sanitary and easily built. It can be made of metal or wood.

containers. Oyster shell or fine limestone grit should be provided after the pullets are four months of age, or when they begin to show evidence of reaching maturity (comb development). Charcoal may be fed, but recent scientific investigations show there is no advantage in the practice.

RATIONS AND METHODS OF FEEDING CHICKENS[1]

Starting and growing mashes, Table XX. First feed to maturity.

Grain mixture. Fifth week to maturity.

50 pounds of cracked yellow corn   50 pounds of whole wheat

Other feeding suggestions. When liquid skimmilk or buttermilk is available as a drink, or when the chicks have access to condensed buttermilk, the dried milk products can be omitted

[1] Rations suggested by Cornell University. Those who wish to use the suggested method of feeding with a mash of different formula should have equally good results, if the mash mixture is similar in protein and vitamin content to the mixture given here.

from the mash. Likewise, when chicks more than eight weeks of age are on good green range, or are consuming plenty of leafy green feed, the dried milk by-products as well as the

TABLE XX

STARTING AND GROWING MASHES

INGREDIENTS	MODIFIED CHICK-MASH MIXTURES		
	No 1	No. 2	No. 3
	Pounds	*Pounds*	*Pounds*
Yellow cornmeal	750	550	670
Wheat flour middlings	400	400	400
Wheat bran	200	200	200
Ground oats, low fiber	200	200	200
Soybean oil meal		200	..
Meat scrap (55 per cent protein)	200	200	100
Dried skimmilk or dried buttermilk	100	.	130
Dried whey		100	.
Dehydrated alfalfa meal (17 per cent protein)	100	100	100
Corn gluten meal			150
Pulverized limestone	40	40	40
Salt	10	10	10
Total	2,000	2,000	2,000
Manganese sulfate	4 ounces per ton		
Vitamin D from fish oil or activated animal sterols * when necessary	360 A. O. A. C. units per pound		
Protein %	17.8	19.7	17.7
Calcium %	1.8	1.8	1 4
Phosphorus %	.9	.9	.7
Vitamin A units per pound	7,200	6,880	7,582
Riboflavin units per pound	1,837	1,826	1,348

* Since activated animal sterols are ordinarily not fortified with vitamin A, dehydrated alfalfa containing 75,000 or more units of vitamin A per pound should be used to ensure adequate vitamin A in the ration.

If the vitamin-D potency is expressed in units per gram, multiply it by 454 to obtain the number of units per pound.

alfalfa meal may be omitted from the mash. (Table XX, rations 1, 2, and 3.)

Because milk soon sours in a warm room, it is best to feed liquid milk sour. Many poultry-keepers consider it poor management to change from sour to sweet or reversely from sweet to sour. Experimental evidence, however, shows that it makes no difference whether milk is fed sweet or sour. The acid in

sour milk seems to stimulate the appetite but has no other effect.

Vitamin-D products may be omitted from the ration during the summer when the chickens run out-of-doors daily.

The proportion of corn and wheat in the grain mixture may be varied somewhat according to the price of these grains. The feeding of whole oats may be started when the chicks are 6 weeks of age and whole corn in place of cracked corn at 10 or 12 weeks of age.

Fresh green food is a valuable part of the ration; consequently, a good pasture should be provided when possible.

Feeding broilers. Broilers may be fed the same mash and grain mixtures as indicated on page 170. However, since broilers are usually raised indoors, it is advisable to use a mash that contains either alfalfa meal or corn gluten meal, or both, to give the birds more color.

It is general practice among broiler growers to feed grain for the first two days and then all mash for the next few weeks. Beginning at 6 or 7 weeks of age, grain is fed in increasing amounts. During the last ten days or two weeks before the birds go to market, large amounts of cracked yellow corn are fed to give the shanks and skin a deeper yellow color.

Chicks started on grain learn to eat more readily than those started on mash; the bowels are less laxative; and there is less pasting of the vents.

MANAGEMENT OF GROWING CHICKENS

Next year's profits or losses depend largely on the way pullets develop. Consequently every detail must have close attention. An abundance of clean, wholesome food and drink must be available at all times. Growing chickens should have unlimited grass, clover, or alfalfa range, and shade.

Feeding and management of growing pullets. Some poultrymen think that by reducing the protein in the ration, or by feeding little mash and mostly grain, they can control the age at which pullets begin to lay. This practice is not supported

by experimental evidence, and may be detrimental to the birds if carried too far.

Rate of growth and sexual maturity are two separate factors. Both are inherited. Early sexual maturity is associated with high egg production, and is controlled almost entirely by breeding. In other words, the tendency is for high-producing hens to start to lay early in life and to transmit this early maturity to their offspring. If later maturing pullets are desired, it will be necessary to select breeding hens that are slower in maturing.

Rate of growth, or physical development, although inherited, is more readily affected by the quality and kind of feed or management that the birds receive than is sexual maturity. The vitality and disease-resisting powers of pullets may be affected if they do not receive a ration that permits them to grow normally. Pullets usually reach sexual maturity before their bodies have fully developed. They complete their development after laying starts. It is well to keep in mind that the degree of physical development at this time is particularly influenced by the protein level, vitamins, and minerals supplied during the first three months of growth.

Low-protein rations fed early in the life of chickens tend to retard growth, while high-protein rations speed it up. Rations carrying less than 15 per cent of protein would be considered low, and those having more than 20 per cent are high. The protein requirement of chickens decreases as they grow older. It is not advisable at any time during the growing period to feed a ration containing less than 14 per cent of protein. Because grain mixtures are low in proteins, minerals, and some vitamins, it is a mistake to feed pullets wholly on grain at any period of their growth to try to retard sexual development. This will only delay body growth because of the lack of sufficient protein and other nutrients, and may make them less fit to carry the burden of body maintenance and egg production when they begin to lay. Some mash should always be included

so that an adequate amount of minerals, proteins, and vitamins is provided.

Before the chickens are a month old, one or two poles are placed across the back part of the brooder house or pen, a foot or two from the floor, to train the chickens to roost. Such roosts

TABLE XXI

AGE AND AMOUNT OF FEED REQUIRED PER BIRD BY COCKERELS AND PULLETS AT GIVEN WEIGHTS FOR S. C. WHITE LEGHORNS AND AMERICAN BREEDS [2]

KIND	WEIGHT OF CHICKS IN POUNDS	(1) AGE IN WEEKS	(2) FEED USED TO DATE	(3) FEED FOR 1 LB. OF GAIN	(4) ADDITIONAL POUNDS OF FEED REQUIRED FOR EACH ADDED LB. OF GAIN
Leghorn cockerel	1	6½	2.5	2.5	0
	2	10½	6.7	3.4	4.2
	3	15	12.3	4.1	5.6
	4	22	22.3	5.6	10.0
	5	30	36.5	7.3	14.2
Leghorn pullet	1	7½	3.1	3.1	0
	2	13	8.3	4.1	5.2
	3	20	16.1	5.3	7.8
	3½	26	23.8	6.8	15.4
American cockerel	1	6	2.3	2.3	0
	2	10	6.5	3.2	4.2
	3	12½	9.9	3.3	3.4
	4	16	15.7	3.9	5.8
	5	20	22.7	4.5	7.0
	6	28	36.5	6.0	13.8
American pullet	1	7	3.0	3.0	0
	2	11½	8.5	4.2	5.5
	3	16	14.5	4.8	6.0
	4	22	22.8	5.7	8.3
	4½	26	28.8	6.4	12.0

[2] Data from "Weight Changes in Chickens," by G. F. Heuser and F. E. Andrews (Cornell Extension Bul. No. 240, 1932). These figures are based on records where chicks were fed mash only for eight weeks, and both grain and mash after that time. They had free range on pasture after two weeks. More rapid gains are possible with modern rations during the first few weeks if the chicks are reared in confinement or in battery brooders. Column 4 shows that as the bird nears maturity the amount of feed required to produce a pound of gain increases.

may be a part of a wire-covered frame, one side of which rests on the floor while the other side is fastened to the side wall of the room. Such a frame makes it easier for the chickens to jump up on the poles and keeps them from crowding into the corners.

Early roosting prevents crowding and spreads the birds out so that they have more freedom of action and better air than they would have if grouped close together on the floor. As a result growth is better. As more birds learn to roost and as they grow larger, more and higher roosts should be supplied.

Clean sand, shavings, peat moss, or straw make the best covering for a brooder house during the summer. It is unnecessary to clean such a building more than two or three times during the season unless it gets excessively dirty or wet.

To prevent possible infestation from red mites, the perches and adjacent walls of colony houses should be painted with carbolineum, creosote, or a mixture of crude carbolic acid and kerosene in the fall after the houses are cleaned so that the fumes have a chance to disappear before the chicks are placed in them. Usually one application of these products a year is enough to control the mites; but, if they appear during the summer, the buildings can be sprayed with kerosene or waste oil from automobiles. These materials are not so effective as the first ones mentioned and may have to be repeated several times during the season.

When more than one colony house is in use, too many pullets must not be allowed to form the habit of roosting in one building. The buildings should be at least 100 feet apart. This helps to keep the birds evenly distributed. It is not advisable to try to house more than 125 growing pullets in a colony house or range shelter. Good ventilation is essential on hot nights. In addition to the regular ventilators, the glass sash in the front of the colony house is removed.

Range shelters with wire floors may remain in the same location all season or may be moved once or twice if there is

too great an accumulation of manure or the grass is likely to be destroyed over a wide area around it. The manure should be cleaned up after the shelter is moved.

Where there are many hatches and several weeks difference in their ages, each group or hatch should have a separate range, or the houses should be placed much farther apart than for groups of the same age. Otherwise, the older pullets will annoy the young ones and prevent normal growth.

When the same number of sexed pullet chicks are started in a brooder house or pen as unsexed chicks, the number should be reduced to not more than 150 after six weeks to prevent crowding. Extra houses, pens, or range shelters should be provided for this purpose.

Water supply. Running water automatically controlled is a great labor saver for chickens on range and assures an ample supply of water at all times. However, precautions should be taken to prevent chickens from working continually in moist areas of soil around the watering places. It is suggested that a wire- or slat-covered frame 4 feet square and 8 or 10 inches high be built for each water container (Fig. 78). A shallow pit should be dug under the platform to catch the water. The use of this arrangement is of considerable value in controlling coccidiosis and roundworms.

Fig. 78. An automatic watering device. The trough is placed on a wire screen over a shallow pit. This affords better sanitation. The pipe line is covered with earth to keep the water cool and the roof helps to keep the water in the trough cool. An automatic valve allows water to flow when water is removed from the trough and releases the valve.

If water cannot be piped to the range and must be hauled by truck, a milk or oil barrel may be used as storage and a waterer (Fig. 79). Water may be released from the barrel by means of an automatic float valve near the bottom. If the barrel is placed on a wire- or slat-covered sled, it can be moved

frequently to prevent bare wet spots. This arrangement saves considerable labor.

Segregation of sexes. As soon as the cockerels can be easily distinguished and are large enough for broilers, they should be segregated from the pullets. This is particularly true of Leghorns and other rapidly growing breeds, because they develop sexually early in life and begin to annoy the pullets.

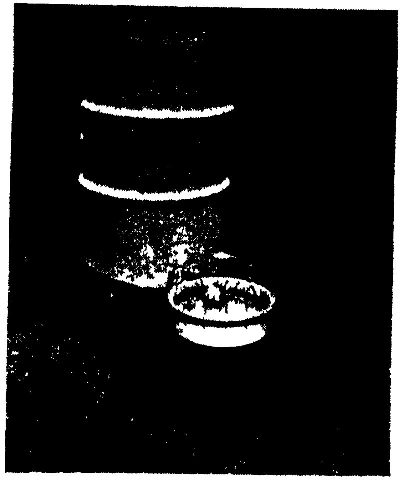


Fig. 79. A range waterer.

When properly grown, most all breeds weigh 1 pound (average of both pullets and cockerels) in about 7 weeks, and 2 pounds in 10 or 12 weeks (Table XXI). Battery-grown birds reach these weights about one week earlier. The birds that are not needed for breeders should be marketed as broilers, friers, or roasters.

Cockerels for breeding purposes should be selected when they are of broiler size. Those that have made the best body growth, show good vigor, together with rapid feather growth and moderate comb development, and have well-pigmented shanks, make the best prospects. About three times as many cockerels should be selected as are needed for breeding purposes, as it is usually necessary to discard many birds before they are fully grown because of defects.

The breeding cockerels should have a grass range by themselves, the same as the pullets, with all the necessities of life.

Clean ground and disease prevention. The two essentials for disease prevention in a flock of growing chickens are the provision of clean ground for them to run on each season and the

protection from the old stock which may harbor disease. One depends on the other. When properly carried out no part of the rearing program is more important.

Obviously, the place to begin a disease-prevention program is with the old stock. This is because it has been definitely proved that the old stock harbors disease and is often the principal means of carrying disease to the young stock. To cut down the spread of disease from old to young stock, the following preventive measures should be observed: (1) Never allow old and young stock to mix or even use separate parts of the same building. (2) Dispose of the droppings and litter frequently by spreading them on land not used for poultry and on a distant part of the farm or in a fly-screened pit or bin. Storage in a pit is desirable since it results in heating which destroys coccidiosis organisms and worm eggs. (3) Prevent tracking disease to chickens on clean land. Either have a separate caretaker for the young chickens, who should never go near the old stock, or have the caretaker change his rubbers, boots, or shoes, and his outside garments, when he goes from the old to the young stock or from the young to the old. (4) Never use in the pens of the young stock the crates, implements, feeders, and the like, that have been used in caring for the old birds unless these implements and the like have been thoroughly disinfected. (5) Burn all carcasses of dead birds.

If the precautions against carrying disease from old to young stock are followed carefully, then the practice of growing the young stock on clean land increases in importance as an aid in preventing disease.

Many persons do not understand what is meant by clean land. Clean land is a field on which fowls or chickens have never ranged, or at least not for two years, or where poultry manure has not been spread within this time.

Many common poultry diseases and parasites, such as coccidiosis, range paralysis, and worms, may be spread over the yards by the droppings from young and old stock. When

the same ground is used regularly for several years, great numbers of germs and worm eggs may accumulate in the soil. The greater the number, the greater the chances for infection. It is well known that some of these germs live for weeks or months, and even from one growing season to the next, in the soil. This is called *soil contamination.*

Rotate ranges. To have clean ground each year, a land-rotation system should be practiced. The best plan is to have three entirely separate rearing ranges. Each range can then be used once in three years. When this plan of land rotation is in operation, an acre of land should be allowed for each 600 growing chickens. This should give the birds plenty of green food during the entire growing season.

Each range should be in permanent pasture and either grazed or cut frequently during the years it is not used by poultry. Where cattle are kept the chickens may be rotated around the cow pasture. Each year the brooder houses or range shelters can be arranged in a line 100 feet apart with the feeders and waterers in between them. An electric fence around the buildings will keep the cattle away from the buildings and feed. At the same time it will not be necessary to mow the grass as often as the cattle will keep it grazed.

Recent tests show that heavy applications of lime on the land do not destroy disease organisms, but do help in many instances to sweeten the soil so that clover or alfalfa will grow.

Clean land is not a cure-all, but most poultrymen know that chickens usually do well if started in new houses on clean land. It is sometimes called beginner's luck. But it is not all luck; it is freedom from disease and parasites. Chickens may have any of the diseases or parasites mentioned when they are grown on a new clean location, but, if the precautions mentioned are followed carefully, the chances are less.

Although the rotation plan is generally accepted as the best disease-prevention practice, not all poultry-keepers are able to follow it. Some may not have enough land, others may be

using large permanent brooder houses. In either case the chickens should be reared in confinement. With this system, the chickens do not set foot on the ground for several weeks at least, and sometimes not at all during the season. When additional floor space is needed, the chickens are allowed to run out-of-doors on 1-by-2-inch-mesh wire-covered platforms,

Fig. 80. Brooder houses for confinement rearing. Confinement rearing is a disease-prevention practice if the land near at hand is contaminated. The chicks do not set foot on the ground for several weeks or not all all during the season. The platforms provide ample space for exercise and access to sunshine and fresh air. Locating the brooder houses close together when the chickens are small and confined saves labor.

supported 1 foot above the ground (Fig. 80). Usually about as much platform space is provided as for the birds on the inside. Every effort should be made to encourage the birds to use the outside space, because they will be benefited by the sunlight and fresh air. This can be accomplished by placing the feed hoppers and drinking receptacles in the outside enclosure.

The outside wire platforms can be made of 1-by-6-inch boards set on edge and covered with 1-by-2-inch welded wire. This heavy wire is necessary, as light wire soon breaks down. Beveled supports every 2 feet keep the wire from sagging. The platform is elevated, a foot or more above the ground, on legs to make it easier to clean underneath.

Detachable panels, or common 1-inch chicken wire 2½ feet

wide and the necessary length, should enclose the sides of the platform, while other movable sections of common 2-inch-mesh chicken wire form the top.

Rearing in confinement. Confinement rearing prevents soil contamination which is likely to occur with permanently located brooder houses. When chickens are grown in such houses, or kept in confinement during the first eight or ten weeks it is highly desirable that they finish their growth on clean land, for growth is likely to be more normal due to natural conditions. The rearing of pullets to maturity entirely by the confinement method is to be resorted to only when the soil is so badly contaminated that it is absolutely impossible to grow pullets otherwise without disease.

Confinement rearing, while having the advantage of cutting down the dangers from disease, nevertheless has its difficulties. The worst of these is feather picking and cannibalism. Even these bothersome habits may be reduced to the point where they are not serious if care is taken to prevent crowding. Poultrymen who have had serious trouble with contaminated soil have been only too glad to put up with some of the disadvantages of confinement brooding to escape the disastrous inroads of disease.

Wire floors for the brooder house. Some poultry-keepers used ¾-inch-mesh-hardware-cloth frames on the floor of the brooder house. This arrangement makes it possible to do without litter and saves considerable labor in cleaning. In spite of these advantages the use of wire floors has never been popular with poultrymen, perhaps because it calls for additional expense and also because the frames make it difficult for the attendant to move around the pen.

If wire floors are to be used, the following suggestions may be helpful: In place of one large frame that covers the entire floor, several smaller frames that fit the space conveniently may be used. These make cleaning easier. The frames may be made of 1-by-6-inch boards set on edge, with the corners of the

top edge planed off to a narrow ridge so that few droppings will lodge there. Beveled supports across the frames are needed every 18 inches. Wire frames prevent suffocation if the chickens crowd.

Losses from natural enemies. Hawks, crows, owls, rats, foxes, skunks, weasels, cats, and dogs are the most dreaded natural enemies of growing chickens. If a poultryman has had trouble with any of these pests in other years, it will pay him to give some thought to reducing such losses.

Hawks and crows. Hawks and crows are the most common pests. They are cunning and daring, and not easily frightened away. Once they start to harass a flock they continue until the chickens are nearly full-grown. They usually make their raids early in the morning and late in the afternoon about sunset. Hawks and crows generally watch from some moderately high point for an opportunity to pounce upon their victims unexpectedly. They may be caught in small steel "jump traps," placed on top of tall fence posts or short poles near the brooder houses (Fig. 81). Sometimes crows are frightened away if one or more are killed and hung up where the chickens range.

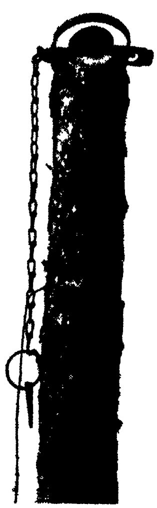


Fig. 81. Hawks, owls, and crows are caught by setting small steel "jump traps" on the top of fence posts or poles. Note the ring is on a wire fastened to the pole. This permits the trap to fall to the ground when it is sprung.

The Maine Agricultural Experimental Station succeeded in keeping hawks and crows away by tying streamers, a few feet apart, to twine strung across the field above where the chickens ranged.

One sure way to prevent loss of very small chickens from

hawks and crows is to fence a small area of ground and cover it with 2-inch-mesh wire. Confinement rearing in such cases is an advantage.

Rats and weasels. The best way to control rats and weasels is to close or remove all of their possible breeding and hiding places. The brooder houses should be placed at least 150 feet from the nearest permanent building, stone wall, or hedge. Refuse or material that might harbor small animals should not be left near the houses. The grass near the buildings must be kept short. The floors of portable colony houses should be at least 1 foot from the ground, and the space underneath open and free. Permanent brooder houses should have cement floors; the doors and windows should be screened with 1-inch-mesh wire fencing.

Skunks, foxes, dogs, and cats. If skunks, foxes or dogs bother the chickens, a fence 5 or 6 feet high, with the bottom sunk in the ground 3 or 4 inches, may be a good investment. Skunks may be trapped when the law permits. When a cat forms the habit of catching little chickens, the only remedy is to kill the cat.

Owls. Owls kill many chickens that roost in trees or exposed places. They even enter the open windows of brooder houses. If traps on the top of poles fail to stop their depredations, the windows of the brooder house must be screened and the chickens confined at night.

BATTERY BROODING

The rearing of chickens in batteries (Fig. 82) is a comparatively new method. It is an attempt by man to substitute mechanical means for nature's way. The reason for this has been the need of better methods of combating disease and reducing labor costs.

There has been much confusion about the proper use of batteries and methods of handling chicks in batteries. The consensus of opinion after several years' use seems to be that

batteries have three distinct and practical uses: (1) by hatcherymen for storing surplus chicks until they can be sold; (2) by poultry-keepers for starting chicks; (3) by the poultry-keepers who grow chickens for the broiler trade. It is not advisable in growing pullets to maturity to keep them in batteries longer than about three weeks, for the older the birds are when the change is made, the more they are upset by it.

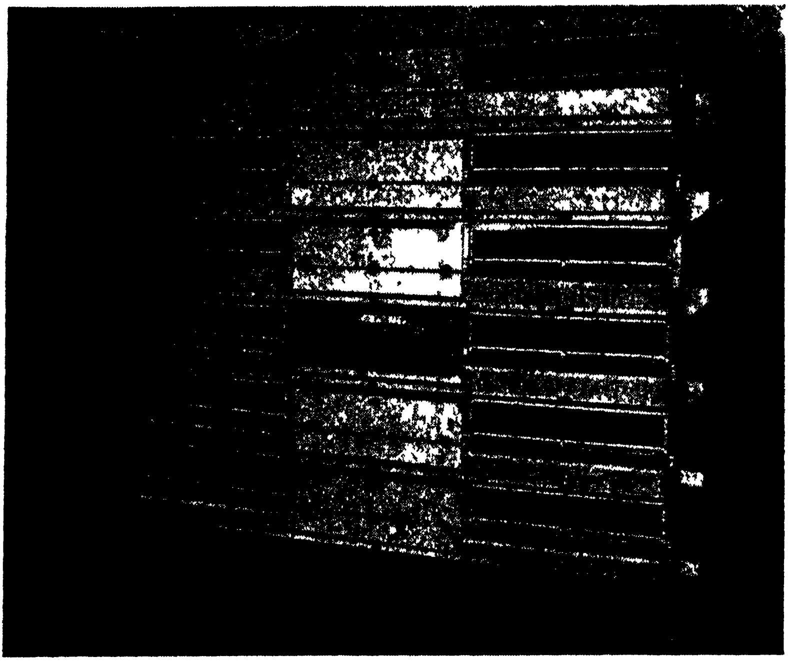


Fig. 82. A heated battery for chicks. The heating element is in the center. Note feeders on the front and water receptacles on each end. Castors make it easy to move.

Battery brooding is probably best adapted to large poultry farms where several thousand chicks are to be brooded. Unless the equipment can be used several times during the season, the overhead expense is high. However, for the poultryman who has from 2,000 to 3,000 or more chicks to brood, battery brooding takes a lot of drudgery out of the operation and

saves considerable labor and time in getting the chicks started.

Kinds. Batteries are of two general types; heated and unheated. The choice of one or the other of these depends somewhat upon the facilities of the operator. Some poultrymen use the heated ones for the first three or four weeks and then transfer the chickens to unheated batteries in a heated room. The different makes of batteries vary in the type of heater. Some have what is known as a *contact heater* in the brooding compartment against which the chicks rest their backs. This compartment can be adjusted according to the size of the chicks. This type of heater imitates nature quite closely and has much to recommend it. Other types are used also with satisfaction.

New buildings can be made of hollow tile, concrete blocks, or wood properly insulated. The floor should be of smooth-surfaced cement, to facilitate cleaning. The height of the battery unit, about 6 feet, should be taken into consideration in constructing new buildings or remodeling old ones. There should be 2 or 3 feet of space between the top of the battery unit and the ceiling for air circulation, so that the chickens in the top compartments will not suffer from the hot humid air which may collect near the ceiling in warm weather. In cold weather usually it is necessary to provide heat in the battery room to maintain a room temperature of about 60° F.

A well-insulated building is necessary for efficiency and economy in operation. Good insulation may be obtained by stuffing the side walls with shavings, rock wool, or spun glass. The ceiling should be covered with the same materials.

As a precaution against the introduction of disease, the battery room should be completely separated from the incubator room and poultry house; *better still in a separate building.*

Capacity. There is a tendency to overrate the capacity of batteries beyond the first week or two. *Crowding should be prevented,* for it results in retarded growth and poor feathering and leads to feather picking and cannibalism.

A 3-by-3-foot battery compartment provides ample room for 100 chickens for ten days or two weeks. After that time it is customary to double the floor space about every two or three weeks until the birds are ten or twelve weeks old. The following table gives the average capacity recommendations at different ages.

First to third week	not more than from 75 to 100 chicks
Third to sixth week	not more than from 35 to 50 chicks
Sixth to twelfth week	not more than from 18 to 25 chicks
Twelfth week and after	not more than 15 chicks

Some operators allow a little more space for heavy breeds, such as Plymouth Rocks and Rhode Island Reds, than for light-weight breeds, as the Leghorn.

Feeding. Because chickens grown in batteries are wholly dependent on the operator for their food and do not have an opportunity to overcome deficiencies in a ration with natural food, it is important to use a ration known to give good results. The regular chick rations are suitable. The method of feeding described for broilers (page 172) works well. For *straight broiler production* a higher protein (from 20 to 21 per cent) ration is advisable for the first month.

It is suggested that ration 3 (Table XX, page 171) be used for broiler production. This tends to give the skin on the shanks and body a deeper yellow color.

To teach the chicks where to get their food and drink when they are first placed in the battery, some operators provide feed on newspapers or in shallow box covers and water in fountains on the floor of the compartment for a day or two. The feed troughs should be filled level full at first and should be well lighted to attract the chicks.

Operating temperature. When the chickens are first placed in the battery, a temperature of 90° F. should be maintained for the first forty-eight hours. After that the temperature is lowered about a degree a day until a temperature of 70° or 75° F.

is reached. The chickens should be comfortable at all times. On the other hand, as low a temperature should be maintained as is consistent with comfort after the first day or two, as low temperature increases the rate and quality of the feather growth and tends to prevent picking.

Ventilation. The ventilation of battery rooms is important, especially in warm weather. Intakes are usually provided either through windows or openings in the sides of the room near the floor or through the floor. One or more outlets are made at the highest point in the room. Both the intakes and outlets should be designed so that the amount of opening can be regulated and there will be no drafts on the birds.

Electric fans are generally used to speed up natural ventilation, particularly after the chickens are a few weeks old and when the weather is warm. They are usually placed in ventilator outlets in the ceiling or in specially constructed ventilator shafts in the room.

Fans are often used in the battery room to stir up the air and to equalize the temperature in all parts of the room.

Moisture. Moisture has its part in growing chickens in batteries. Proper humidity aids in feather development and takes the place of heat. Most operators report best results in starting batteries when the relative humidity in the room is kept between 70 and 75 per cent. This is soon reduced to from 50 to 60 per cent.

Cannibalism. A number of battery operators have had trouble with cannibalism. Several conditions may be wholly or partially to blame for this. Overcrowding is one of the easiest ways to start the vice. Too low a humidity or too high a temperature is believed to be conducive to picking.

Too much light or the use of bright lights which shine inside the batteries is harmful. The light should be arranged so that it shines on the feed and water pans but not inside the battery. Occasionally it will be necessary to replace the regular light bulbs with ruby-colored lights to stop picking. The use of

anti-pick will often stop the vice. Extra salts is suggested also.

Sanitation. It is important that strict sanitary measures be practiced in and around the battery rooms at all times. Once disease gets started, where so many hundreds or thousands of chickens are confined in so small a space, it spreads rapidly and is hard to control.

The dropping pans should be cleaned at least twice a week; if large numbers of chickens are being brooded, once a day is better. Newspapers are sometimes used on the bottom of the pans as an aid in cleaning. Half of an oil barrel or a tank filled with a 3 per cent compound-cresol solution makes a good place to disinfect the pans and other parts of the battery after cleaning.

The batteries should receive a thorough cleaning and disinfection a number of times during the season for it is much easier to devote a little time to disease prevention than to try to cure it once it is under way.

Lights. The relation of lights to picking and cannibalism has been mentioned. The replacement of bright lights by dim ones as soon as the chicks have learned to eat is recommended. Too much light makes the birds restless and easily frightened. The daily-light period should be limited to not more than 14 hours. This gives the birds a period of complete rest. Better condition and vigor usually result.

Breast blisters. Many poultry-keepers report considerable trouble with breast blisters when they try to grow chickens in batteries beyond the broiler size or about 2 pounds live weight. The blisters may be brought on by several things. The most common cause comes from the bird sitting down to eat and dragging the breast on the wire bottom. Sitting down on the wire at night still further aggravates the trouble. Insufficient head room also increases the trouble. Adjusting the feed trough so that the birds can stand up to eat, and providing small portable roosts to keep the birds off the wire at night, help to prevent this trouble.

X. Choosing a Ration

POULTRY is kept primarily to convert feeds into meat and eggs. The hen is the machine and the various feeds are the raw materials. Meat and eggs are the manufactured products. The success of this operation will depend upon the birds having the right qualities through inheritance, a favorable environment, good health, satisfactory food and proper management.

The feeding of laying hens naturally divides itself into two parts: first, that which has to do with the selection of the food; second, the method of feeding. It is difficult to state which is the most important, for each is dependent on the other for successful results.

The purpose of a ration for egg production is also twofold. First of all it must furnish heat, energy and all the other materials necessary for the upkeep of the body. From 75 to 80 per cent of the feed consumed, generally speaking, goes toward maintenance of the body. The balance of the feed can then aid in building of new tissue or the production of eggs.

In building a ration, account must be taken of the nature of a hen as well as the feed and eggs. Poultry differs from other farm animals in many ways, but particularly in the use of food. The hen has a higher body temperature (106.7° F.) and greater activity. As a result, the processes of digestion and assimulation are more rapid and the food requirements are proportionately larger. This is especially true of growing chickens. According to W. H. Jordan of the New York (Geneva) Experiment Station, a hen eats in proportion to her weight more than twice as much dry matter in a given time as does a cow and uses food more efficiently than any other farm animal. A hen's digestive system, being short and not

very complicated, is best adapted for the proper use of the more concentrated feeds. Hens have neither the capacity nor the structure to digest the bulky fibrous feeds such as is possible for a cow. A certain amount of bulk is needed in a ration, however, to aid digestion.

NUTRIENTS AND THEIR FUNCTIONS

All feeds, as well as the hen's body and eggs are made up of various combinations of chemical compounds known as nutrients. There are six important groups of these nutrients. They have definite functions or uses in the hen's body and they must be supplied in right amounts if the hen is to live and function normally.

Most natural feeds contain all these nutrients, but each has them in varying amounts. Certain feeds may have larger proportions of one or more nutrients than others. This requires an adjustment of the quantities of different feeds used so that the total amount of each nutrient supplied by the ration as a whole will meet the needs of the hen.

The six feed nutrients are classified according to chemical, physical and biological properties into six general groups: protein, carbohydrates, fats, minerals, vitamins and water. The more important parts they play in the cycle of life are shown in Table XXII.

Although there is some similarity between the occurrence of these nutrients in feeds and in the hen's body or eggs, most of the feed consumed is broken down into simple substances by the process of digestion and reassembled as needed in different combinations as body tissues and eggs.

PROTEINS

The proteins in feeds are compounds that always contain the chemical elements of nitrogen, carbon, hydrogen and oxygen. Most proteins contain sulphur, and some also contain

phosphorus and iron. Nitrogen is the important element in proteins..

Proteins are found in all plants and annuals. Since they form a part of the protoplasm and nuclei of cells, they are necessary to life. In plants, most of the proteins are concentrated in leaves and seeds. Muscles, nerves, feathers, internal organs, beak, scales, blood, and the white (albumen) of the egg are largely composed of protein and are maintained and

TABLE XXII

RELATION OF NUTRIENTS IN FEED TO THE FOWL AND EGG

FEED	USE IN FOWL	USE IN EGG
Proteins	Muscles Blood Nerves Internal organs Feathers	Albumen Yolk proteins
Carbohydrates Fiber, starch, sugar	Energy Heat Body fat	Yolk fat
Fats	Body fat Energy Heat	Yolk fat
Minerals	Bones Body tissues Blood	Shell Yolk
Vitamins	Vital organs and functions	Yolk Albumen
Water	Body fluids	Water in yolk and albumen

developed by the protein in feeds. Proteins constitute about 12 per cent of the whole egg and 25 per cent of the live weight of the chicken.

Proteins are necessary for growth and repair of tissues. They may also serve as a source of energy when more is consumed than is required for growth, egg production and repair of tissue. However, the excessive use of protein is not economical as protein concentrates are usually the most expensive feeds.

Although there are many different proteins, all of them are

composed of simpler substances known as amino acids. There are 25 amino acids. Twenty-two of these are usually present in varying amounts in every protein, but some may be lacking.

The chicken can make some of the amino acids in its own body and most of those it cannot make must be present in the feed, otherwise normal nutrition is impossible.

The amino acids which the chicken is unable to make in its own body, but are required for growth and egg production, are known as the *essential* amino acids.

CARBOHYDRATES

The carbohydrates are made up of carbon, hydrogen and oxygen and are divided into two classes—fiber and nitrogen-free extract. Carbohydrates occur in very small amounts in animal tissues. They comprise about 75 per cent of the dry weight of plants and cereals and are, therefore, an important part of the chickens' feed.

Fiber is the woody or cellulose tissue of plants. It is of little direct food value to a hen since only a small amount can be digested. However, it adds bulk to the ration and distends the intestines so that digestive juices have a better chance to work on the food.

Nitrogen-free extract is made up mostly of starches and sugars. The body uses these materials to supply heat and energy. The excess is stored as fat.

FATS

Fats contain the same elements as carbohydrates except they have a higher energy value. They supply about 2¼ times as much energy as does the same weight of carbohydrates and protein. About 20 per cent of the live weight of a chicken and 9 per cent of the weight of fresh eggs are fats.

MINERALS

When a feedstuff is burned the ash that remains is the mineral matter in the feed. About a dozen minerals are thought

to be necessary for poultry; some of them in trace amounts. All body tissues are not complete without them. Their distribution and concentration varies. The bones, for example, require large amounts of minerals, particularly calcium and phosphorus. Iron is concentrated in the blood and egg yolk. Egg shells are made up largely of calcium while the yolk of the egg has a considerable amount of phosphorus and sulphur.

The different minerals are closely bound up with life and help to control its processes. A lack of minerals affects digestion, respiration, bone development and the proper functioning of the muscles and nerves.

About 10 per cent of the weight of a fresh egg and 3 per cent of the weight of a chicken are minerals.

VITAMINS

Vitamins are the newest group of nutrients. They are essential for growth, reproduction and the maintenance of health. Although only small amounts of the vitamins are needed, it is absolutely necessary to supply each of them for its special function.

What is known as a nutritional deficiency disease develops when there is a prolonged deficiency of one of the vitamins in the food of an animal. Each disease has characteristic symptoms which make it relatively easy for an experienced person to determine the cause of the deficiency.

WATER

A regular and abundant supply of water is important if good egg production and growth are desired.

The grains which are the largest part of the chickens' food supply usually contain from 10 to 12 per cent water. Some of the kiln dried feeds may have as low as 5 per cent. Only the succulent green feeds have large amounts of water. On the other hand, the hen's body is composed of 55 per cent water and the egg has about 65 per cent. A dozen eggs, for example,

which weight $1\frac{1}{2}$ pounds contain about 1 pound (1 pint) of water. All the processes of the body, such as digestion, absorption and secretion, take place in water as a solvent. A lack of water not only affects the processes of digestion and assimilation, but it thickens the blood and raises the body temperature. The need for more water than is supplied by the feed is apparent. An insufficient or irregular supply quickly manifests itself in lowered egg production, poor growth and loss of flesh.

THE HEN'S BILL OF FARE

Usually whole grains form a large part of the diet of fowls because they are naturally seed eaters. However, if the best production or growth is desired, ground cereal by-products, animal and vegetable concentrates, vitamin carrying feeds, mineral feeds and water must be added to the bill of fare. Fowls must have a variety of feeds because in no one feed or group is there a full supply of all the nutrients required for normal egg production.

WHOLE GRAINS AND BY-PRODUCTS

Whole grains are very rich in carbohydrates and fats and are the cheapest and best sources of these nutrients. Their value in producing heat, energy and fat is very high, but they usually run low in proteins, minerals and vitamins.

Whole grains are usually fed in mixtures made by combining the different grains in proportion to their feeding values. Cereals may be fed separately.

In selecting grains and determining the proper proportions to use, palatability, digestibility, availability and price should be considered. A good rule in making up a scratch grain mixture is to use at least 60 per cent yellow corn or wheat, or both. The balance of the mixture may consist of a combination of any two or more cereals such as oats, barley, etc.

Grains, when shipped interstate, must be graded by U. S.

Standards[1] according to moisture content, weight per bushel, soundness of kernels and freedom from weed seeds and dirt. Purchasers should take advantage of this fact in buying grain and buy according to grade. It is not enough to call for just corn or wheat, or any other grain for which standards have been set, if a certain quality is desired.

It is important in selecting the ingredients, especially the by-products and concentrates, for a ration to have as much information about the chemical composition, vitamin content and digestibility of the feeds used as possible.

The relative merits of the common grains and their by-products follow.

Barley is similar to wheat in composition, but is not as palatable. It contains a medium amount of fiber, but makes a desirable poultry feed. Barley may be substituted for part of the wheat in a mixture. However, it should not make up more than 40 per cent of the grain mixture. Ground barley, or oats and barley, may replace ground oats, pound for pound, in a mash formula.

Buckwheat is an important feed in localities where it is grown. It has a thick, dark brown husk which makes it run high in fiber. Fowls often do not eat it readily because of its dark unattractive appearance. The digestible portion ranks with corn as a source of carbohydrates. It is best fed in winter in amounts not to exceed 30 per cent of the scratch grain.

Ground buckwheat or buckwheat middlings may be used to replace ground oats in a poultry mash, pound for pound.

The feeding of large amounts of buckwheat produces a light colored egg yolk and lighter skin color.

Yellow corn is a popular, important and desirable poultry feed. It is very palatable, contains a large amount of digestible nutrients, has a low fiber content and is attractive in color. It

[1] Further details about U. S. Official Grain Standards may be obtained from a government handbook for sale by the Supt. of Documents, Washington, D. C.

can usually be bought in any feed store and is generally one of the cheapest feeds.

Two chief types are grown: dent and flint. They are about equal in feeding value. Flint corn is harder than dent corn.

New corn may be fed to poultry as soon as it is dry enough to shell. Its feeding value increases as it loses moisture. If stored for a year or more, however, yellow corn tends to lose some of its vitamin A.

Because it contains a very large amount of carbohydrates, it is excellent to use with other grains of less value in this respect. Yellow corn also contains a fair amount of vitamin A which is not present in other cereals. White corn does not contain any vitamin A and is, therefore, not as valuable.

Yellow corn contains xanthophyll, a pigment which imparts a deeper color to the yolks of eggs and the body skin than other cereals.

Corn is usually fed cracked, especially if it is a part of the grain mixture. In this form, it is more quickly digested than whole corn and gives the birds more exercise in hunting for the particles. When home-grown corn is fed it is questionable whether it pays to have the corn cracked or not. This is particularly true if the cracking is not done by the proper milling process so as to prevent the loss of the germ or finer parts. The tendency of late is to feed more whole corn. Whole corn may be fed after the birds are 12 weeks old.

Corn meal is the product of the whole kernel of corn after it is ground. It is not sticky when wet and is very palatable. When used in mashes it is more palatable if coarsely ground and higher in feeding value if freshly ground. In warm weather it heats and becomes moldy or rancid quickly, therefore, should be mixed with other feeds or used promptly.

Corn feed meal consists of the siftings from corn when it is cracked. It contains corn, bran, germ and some starchy material and is very similar to corn meal. It varies in composition

and feeding value according to the amount of these materials it contains.

Hominy is derived from corn and is a by-product in the manufacture of corn meal, hominy grits and hominy by the degerming process. It contains corn bran, germ (with or without the extraction of part of the oil) and a part of the starchy portion of the kernel. It carries a little more protein, more fiber and is somewhat more bulky than corn meal. It is usually high in fat and total nutrients and can be used in the same way as corn meal. It is lacking in vitamin A content.

Beans, whole or cracked, may be fed to poultry when cooked or ground and fed in a mash. They are not palatable in any other form and should not be used in large quantities.

Bakery products are sometimes fed to poultry. They have about the same analysis as cereals and may be fed to replace a part of the grain mixture.

Proso millet has been used as a poultry and stock feed in the North Central States for many years. It is known by other names, such as, hog millet, broom corn, millet or "hershey." Proso millet grains are borne in a panicle like oats. They are most satisfactory when fed ground. In South Dakota experiments with poultry, it has been nearly as valuable as corn or wheat.

Oats, if heavy (38 to 40 pounds to the bushel), are very desirable for poultry. Light oats are of less value on account of the excessive amount of fiber. Oats rank next to wheat and corn in palatability. Whole oats may be fed to chickens after they are six weeks old. They are fed whole extensively as an aid in preventing cannibalism. Oats should not exceed 30 per cent of the grain mixture, or 25 per cent of the mash. When used in a mash, they should be finely ground. Sprouted oats were once used extensively as a source of green food and succulence during the winter months. Alfalfa meal and other vitamin feeds now take the place of this succulent green feed.

Peas are a valuable and excellent feed when used in combination with other grains. They contain a large amount of protein and are palatable to hens. When oats, peas and barley are grown as grain, such a combination of feeds can be used as a part of the scratch grain mixture.

Rice is not commonly used as food for poultry, but is a valuable feed and well liked. Rice products are starchy and, therefore, fattening in their effect. They may be used to replace part of the grains in a ration.

Rye, in analysis, is very similar to wheat, but is not palatable to poultry. Large quantities are likely to cause digestive troubles. It may be fed in small amounts.

Sorghum grains are similar to corn in composition, but not as palatable. The principal varieties are milo, kafir, felerita, kaoliang, hegari, durra and shallu. Unlike yellow corn, they are deficient in vitamin A. Yellow milo is generally preferred to the kafirs, the durras and other milos. The sorghum grains may be used as a part of the grain, or, when ground, in the mash. There are no advantages in using them unless they are cheaper than other cereals.

Wheat is the most palatable of all grains for poultry. Compared with yellow corn it has more protein and manganese, but less fat. Wheat and its products contain only trace amounts of vitamin A, whereas yellow corn has large amounts of this vitamin. Otherwise the two cereals are similar in composition and in feeding value. Wheat can replace corn with equal results in growth or egg production, if the amount of vitamin A in the ration is properly maintained. For fattening birds and the production of good yellow color in the skin and shanks, yellow corn is superior.

Shrunken wheat that is unsatisfactory for milling purposes is satisfactory for poultry feeding. Such wheat weighs less per bushel than standard wheat, but contains a higher percentage of protein than does plump wheat. A three year test at North

Dakota showed that shrunken wheat was as good as plump wheat when measured by egg production, mortality, weight of eggs and hatchability. These results were obtained with less feed and lower cost per dozen eggs, because of the lower cost of the shrunken wheat.

Moldy wheat, or wheat screenings, containing weed seeds, are not desirable.

Wheat bran is a by-product in the manufacture of flour and consists of the outer layer of the kernel of wheat which is separated in the process of milling. It is a bulky and fibrous food, low in nutriment and slightly laxative. It is low in calcium, but carries fair amounts of phosphorus and manganese. It is a fairly good source of pantothenic acid. It adds bulk to a ration.

Wheat middlings (standard or shorts) is similar to wheat bran and is the second layer removed from the kernel of wheat in the manufacture of flour. It is not as bulky as bran, but more sticky and contains more nutrients. It is a valuable part of a mash mixture.

Wheat mixed feed consists of the bran and middlings in the same proportions as they come from the mill. It has about the same value as equal parts of bran and middlings, and can be used in place of them.

Flour wheat middlings is also a by-product of wheat in the manufacture of flour. It contains less fibrous material, more protein, and a higher degree of total digestible nutrients than standard middlings. On account of its stickiness, it is not as palatable to poultry and, therefore, should not be used in too large quantities. It ranks a little better than standard middlings in food value.

Red dog flour contains more flour and less fiber than flour middlings. It generally contains some of the wheat germ and is rich in protein, vitamins, and fat.

Wheat germ is separated more or less completely from the

middlings by some of the larger mills and sold as wheat germ meal. It carries large amounts of vitamins B_1 and E, and contains about 25 to 30 per cent protein.

Cane molasses, or blackstrap, is a by-product in the manufacture of cane sugar from sugar cane. It contains mostly sugars and water. It also contains some minerals and vitamins. Cane molasses may replace grain up to 10 per cent of the ration. It is palatable to poultry and acts as a laxative. Beet molasses is much more laxative than cane molasses because of its higher alkaline salts and other laxative substances.

PROTEIN CONCENTRATES

There are two sources of protein: one from vegetables, the other from animals. They are the most expensive feeds used in poultry rations and, therefore, need to be selected with care to be sure that the quantity and quality are sufficient for good growth and egg production. Animal proteins are more palatable and biologically have a higher value than vegetable proteins, with the possible exception of soybean meal. Their mineral content is also higher.

Animal protein feeds are likely to be more variable than vegetable protein feeds because the material from which they are manufactured varies. The high temperature used in their preparation often reduces their digestibility, vitamin content, and biological value. The chief sources of animal protein for poultry are milk and its products, packing-house by-products, and the by-products of the fish industry.

Vegetable protein feeds are not as palatable or digestible as animal protein feeds. Their biological value is less and they are low in mineral and vitamin G content. Vegetable protein feeds are obtained from certain oil-bearing seeds such as soybeans, peanuts, cottonseed, and flaxseed.

Milk. Milk products are exceedingly desirable protein feeds for poultry provided they can be bought at a reasonable price. They are very palatable and easily digested. They are used in

most rations because of their high quality proteins, good variety of minerals, and vitamins. Both skimmilk and buttermilk may be fed in liquid, condensed, or dry form, depending on their accessibility, practicability, and cost. From a nutritional standpoint, one pound of dried skimmilk or buttermilk is equivalent to about 3 pounds of condensed milk. One pound of condensed milk is equal to 3 pounds of liquid milk. Therefore, 1 pound of dried milk is equivalent to about 9 pounds of liquid milk.

Milk products are an important source of riboflavin or vitamin G, which is necessary for growth and hatchability.

Dried or liquid whey, a by-product in the manufacture of cheese and casein, is also a valuable feed for poultry. Dried whey is a particularly important source of riboflavin and pantothenic acid. It is low in protein (12 per cent), has about 72 per cent milk sugar and about 8 per cent minerals. It is fed principally for its riboflavin.

One and one-half gallons of liquid skimmilk or 2 pounds of condensed milk per day per 100 hens, may replace all of the dried-milk by-products in the mash for laying hens. Dried-milk by-products may be omitted from the mash of chicks under 8 weeks of age, if they have liquid skimmilk or buttermilk to drink. Liquid skimmilk or buttermilk will entirely replace meat scrap in the mash, if fowl or chickens are given all they will drink. However, it is advisable to keep some meat scrap or fish meal in the ration as a more complete source of proteins.

Besides its vitamins and protein, milk is beneficial to the health of chickens in other ways. Carrick says: "Lactose or milk sugar favors the development of acid producing bacteria in the intestines and through the multiplication of these 'friendly germs' the objectionable putrefactive bacteria are suppressed, thus providing good intestinal hygiene."[2]

Dried blood is a product of slaughter-houses and, although

[2] Purdue University Leaflet No. 141.

high in protein, is not well digested or palatable to chickens. It is not a very good source of protein for poultry.

Fish meal is a by-product of the fishing industry and an excellent source of protein, minerals, and vitamins. Several types of fish meal are made, depending on the material used and the method of drying. In some cases, the whole fish is used; in others, waste products. Menhaden fish meal is made from small, whole, fat fish; white fish meal from the waste from cod and haddock. Other fish meal is manufactured from the whole fish or waste products of sardine, herring, pilchard, salmon, tuna, and shrimp.

Fish products may be dried by flame driers at high temperature, or in steam-jacketed drums under partial vacuum at lower temperatures. Those processed by the vacuum method at lower temperatures are superior. A good grade of fish meal contains from 50 to 60 per cent protein, is rich in calcium and phosphorus, and a good source of riboflavin.

Meat scraps are one of the by-products of packing houses and rendering plants. It is a ground, dry, rendered residue from animal tissues after the oil and fat are pressed out. Hoof, horn, manure, and stomach contents are excluded, except small amounts which sometimes unavoidably become mixed in, even with good factory management.

Clean, fresh butcher's waste is also a source of meat scraps. Two different processes are used in the rendering of meat scrap, the "wet" and the "dry." The dry rendering process is most commonly used and produces a better product. The composition and feeding value of meat scraps vary widely depending on the amount of meat, bone, glandular parts, and cracklings present. A high-grade meat scraps usually carries from 50 to 55 per cent protein. It is a good source of calcium and phosphorus. Meat scraps is one of the most popular, convenient, and cheap sources of animal protein. It is very palatable and ranks close to milk products in efficiency. Meat scraps should always be wholesome and fresh when fed.

Tankage is another by-product from the manufacture of meat offal or animal tissues. The process of manufacture is similar to that in making meat scraps. The composition of tankage is similar to meat scraps, but it is less uniform in quality and might contain considerable hair and other indigestible material. The protein content is sometimes increased by adding blood meal. Tankage is not used extensively in poultry feeding.

Soybean oil meal is obtained from soybeans by removing the oil by cooking, pressure, and grinding the resulting cake. It is one of the most valuable vegetable protein concentrates for poultry. The raw beans are unpalatable and unsatisfactory as a poultry feed, but thorough cooking not only increases the palatability, but greatly improves the digestibility and the utilization of the protein. Soybean oil meal which has been sufficiently cooked has a pleasant "nutlike" taste and a light brownish or tan color. This product is low in calcium and phosphorus and needs to be fed with other animal feeds and minerals for best results. In chick or breeder rations, soybean oil meal may constitute 50 per cent or more of the protein concentrates.

Corn gluten meal consists of the corn gluten which remains after the kernels of corn have been soaked and the germ, hull, and starch have been separated in the manufacture of starch and glucose. It is palatable and nutritious. It is rich in protein and contains a large amount of vitamin A, but is deficient in calcium and phosphorus. Like soybean oil meal, it must be fed with animal protein concentrates and minerals. Amounts similar to soybean oil meal are used in rations.

Cottonseed meal. This product comes from the ground cake resulting in the extraction of oil from cotton seed. It is cheap and a fairly satisfactory source of protein for poultry. It is rich in phosphorus, but lacks calcium. Like other vegetable protein concentrates it needs to be supplemented with minerals and animal proteins for best results. When used in excess of 5 per cent in a laying ration, the eggs develop green and brown

spots on the yolks after they are held in storage a few weeks. However, recent work from Louisiana indicates that if iron is fed with cottonseed meal, the yolk discoloration can be prevented.

Linseed oil meal comes from the processed flaxseed. It is a fair source of protein, but is sticky and unpalatable to poultry and is little used.

Peanut oil meal. This product is derived from peanuts by methods similar to those described for other vegetable protein concentrates. The quantity produced is small but it is one of the best vegetable protein supplements for live stock feeding. It is palatable and its protein is equal to that of soybean oil meal.

VITAMIN CARRIERS

The feeds listed here are used primarily as sources of certain vitamins, or as vitamin supplements. Animal protein concentrates and all grains and their by-products with the exception of yellow corn are deficient in vitamins A and D. Vitamin G is lacking in cereals. One of the best sources of vitamins A and G is in the leaves of growing plants.

Vitamin D is supplied by direct exposure to sunlight, but other means of supplying this vitamin are necessary when the birds are confined.

Green feed. The fact that green feed has its chief value as a source of vitamins has not been generally known until recently. Many poultrymen believed that fresh green feed was necessary because of its succulence. For this reason, no distinction was made between roots and tubers, which are low in vitamins, and the leafy portions of plants.

Leafy green feeds are rich in carotene which is abundant in feeds containing a yellow pigment called Xanthophyll. Xanthophyll-bearing feeds tend to darken the yolks. Eggs with dark yolks are discriminated against in markets like New York. When candled they are often confused with eggs of

poor white quality. Because of this, most commercial flocks are confined and the amount of pigment-bearing feeds is limited. Usually not more than 5 pounds of fresh leafy green feed is allowed to 100 hens daily.

Dark yolked eggs have greater food value because they usually have a higher vitamin A, D, and G content.

The feeding of green feed frequently helps to control cannibalism by keeping the birds active.

Green pasture. Short, tender green grass or clover provides all the vitamins required by chickens except vitamin D. When the birds have access to pasture daily they will secure this vitamin from sunlight.

Grass also supplies other nutrients such as protein, minerals, and carbohydrates. When poultry is kept on good pasture smaller amounts and less expensive feeds are required. To make the most of good pasture throughout the season, the grass should be kept short and tender by close grazing or frequent mowing. When it is allowed to mature, it becomes tough and unpalatable and loses a large part of its value as food. Less is consumed. The best feeding value is obtained before the grass exceeds 6 inches in height.

Special pasture seedings are recommended for poultry pastures. See page 135 for instructions on planting pastures.

Alfalfa meal is ground alfalfa hay. It is a very valuable feed, for it not only is a good source of vitamins A, E, G, and K but it supplies other vitamins, proteins, and minerals. This feed varies considerably in vitamins, fiber, and protein content depending upon the age when cut, the method of curing, and the soil upon which it is grown. Dehydrated alfalfa meal is usually much superior in vitamin A and G content to that made from sun-cured alfalfa, probably due to quick drying. Alfalfa meal is judged on its color, amount of fiber, and protein content. When it shows extra green color, less than 20 per cent crude fiber and from 16 to 19 per cent protein, it is classed as high grade and listed as alfalfa leaf meal. It is

difficult, however, to judge the vitamin value of alfalfa meal by its protein content and appearance, as length of time stored and the temperature of storage affect its vitamin value.

Although there are no official grades for alfalfa meal, tentative ones have been set up by the United States Bureau of Agricultural Economics based on the appearance, amount of leaf particles, fineness of grinding, and chemical analysis.

Usually from 5 to 7½ per cent of alfalfa meal in a mash supplies the necessary vitamins in the ration without excessive yolk coloring.

Alfalfa hay. Well cured, second cutting alfalfa hay is a good substitute for green grass during the winter months. On the general farm the leaves from alfalfa hay may be fed in hoppers, or a forkful of hay may be thrown in the pen each day.

Sprouted oats furnish a palatable succulent. With the newer knowledge of nutrition and the function of vitamins and green food in the diet of chickens, the use of sprouted oats has diminished. Their feeding value is not increased by sprouting and the labor of preparing them is not justified.

Cabbage, while difficult to store satisfactorily, is a palatable succulent and contains some vitamins. The small and unmarketable heads may be used to advantage for poultry.

Vegetables, such as lettuce, spinach, kale, rape, and the like, may be used to excellent advantage as green food. *Carrots* are the best of the tubers as they contain a considerable amount of vitamin A. *Potatoes* should never be *fed* raw. They may be fed when boiled and mixed with mash. Their chief function is to supply carbohydrates the same as grain. One gallon of cooked potatoes may be used to replace about 1 quart of grain for 100 birds daily.

Fish oils are used primarily for their supply of vitamin D, but are also an excellent source of vitamin A. Cod, sardine, pilchard, salmon, tuna, menhaden, and herring fish oils are sources of these vitamins. The vitamin content of the different

oils varies considerably depending on the kind of fish, the time of year they are caught, and the process in removing the oil. A large part of the oil sold for poultry consists of a mixture of two or more oils and an oil concentrate to give a certain vitamin potency. The potency of oils is measured in A. O. A. C. units [8] determined as the result of feeding tests with chickens. Fortified oils are usually several times as potent as unfortified oils.

Fish oils and other vitamin D supplements are necessary only when birds are kept in confinement where they do not receive sufficient exposure to direct sunlight.

From .25 to 2 per cent oil is used in poultry mashes depending on the method of feeding and the potency of the oil.

When buying fish oils the vitamin content is the important thing, not the price. Most manufacturers guarantee the potency of their oils on the container. The vitamin content of fish oils declines with age and the place stored. The loss of vitamin A is greater and more rapid than the loss of vitamin D. Fish oils should be kept in a cool place and closed to the air. It is not advisable to store feeds containing fish oils more than for a few months.

Vitamin D products, such as animal sterols, may be substituted for fish oils on the basis of their vitamin D potency as determined by the A. O. A. C. chick assay.

CALCULATION OF VITAMIN D

To determine the amount of a vitamin-D product to add to the ration, multiply the requirements for a pound of the ration by 2,000, to obtain the number of units needed in a ton. Divide the number of units required in a ton by the guaranteed potency per pound of the product that is being used to supply the vitamin D. The number obtained (quotient) represents the pounds of the product that are needed to supply the necessary amount of vitamin D.

[8] Association of Official Agricultural Chemists.

Example 1. To determine the amount of a fish oil containing 400 A. O. A. C. units per gram that is needed to supply 360 A. O. A. C. units of vitamin D per pound of starting mash, calculate as follows:

400 units (guaranteed potency per gram) x 454 (grams per pound) = 181,600 units per pound.

360 units (needed per pound of mash) x 2,000 (pounds per ton) = 720,000 units needed per ton.

720,000 units (needed per ton) ÷ 181,600 units (per pound) = 3.9 or 4 pounds of fish oil needed per ton of starting mash.

Example 2. To determine the amount of a vitamin-D product guaranteed to contain 900,000 A. O. A. C. units of vitamin D per pound that is needed to supply 900 A. O. A. C. units of vitamin D per pound of laying mash, calculate as follows:

900 units (needed per pound of mash) x 2,000 (pounds per ton) = 1,800,000 units needed per ton.

1,800,000 units (needed per ton) ÷ 900,000 units (per pound) = 2 pounds needed per ton of laying mash.

Liver meal. Liver is an excellent source of vitamin G and other vitamins. Commercially the amount of this product is limited.

Yeast is an excellent source of vitamins B_1 and G, but usually it is less expensive to utilize other feeds.

Silage. Grass, legume, and cereal grass silage is being advocated for poultry as a substitute for green feed during the winter months. It is a good source of the vitamins found in grass, as a large part of the original vitamin content is retained. It is palatable to poultry and may be fed at the rate of 4 or 5 pounds daily to 100 laying hens. In such quantities, yolk coloring is not excessive. Preliminary results on the Cornell Experimental Farm indicate that good hatchability may be obtained when silage is substituted for alfalfa meal or other riboflavin-carrying feeds; egg production was not increased. Silage provides more vitamin A when this vitamin is needed.

MAKING GRASS SILAGE

Making grass or legume silage is not difficult if the proper procedure is followed. Since grass clippings containing various grasses and legumes usually do not contain enough fermentable sugars to produce sufficient acidity to make good silage, they can be supplemented by adding one pound of molasses to 20 pounds of clippings, but a certain amount of wilting is necessary. Corn meal or ground wheat may also be used at the rate of 2 pounds for each 18 pounds of the clippings. The grain and grass is an excellent combination, is easy to prepare, and no wilting is necessary.

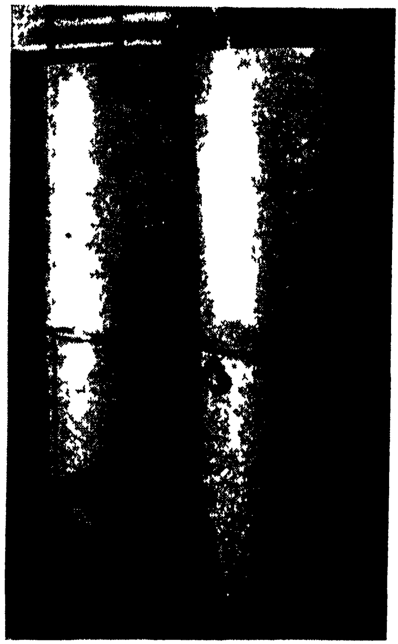


Fig 83. Cans or barrels with straight sides are preferred for making grass silage. Note the cover which fits inside the cans.

SIZE OF SILO

Silage for poultry is usually stored in cans or barrels. Cans with straight sides are preferred, as it is easier to tamp the silage down firmly and there are no air pockets. When 100 birds consume 4 or 5 pounds daily, the recommended amount, about 44 cubic inches of packed silo space per pound, are required.

FILLING THE SILO (CORN GRAIN METHOD)

The steps in filling the silo are as follows:

1. Cut the grass. It should be short and tender (6 in. or less).
2. Cut into inch lengths or less, to facilitate packing.

3. Weigh grass and add proper amount of corn meal (2 lbs. corn meal to 18 lbs. grass).
4. Thoroughly mix corn meal and grass.
5. Fill container a little at a time, pounding *thoroughly* with a heavy weight.
6. When filled, place inside-fitting-board cover on silage and place heavy weight on it.
7. Continue to add more clippings until the fourth day, and then cover and weight it until opened for use.
8. When feeding begins, throw away moldy silage at the top. Remove about one inch or more daily, to prevent molding.

GLASS SUBSTITUTES

Various glass substitutes are on the market which will permit the passage of some ultra-violet rays of sunlight which ordinary window glass screens out. Materials with a wire base allow more rays to pass than those with a cloth foundation. Both products are not very durable and collect dust readily which limits the passage of ultra-violet light. Because of the many handicaps and uncertainty in using these products most poultry-keepers rely on fish oils, or other products, to furnish the proper vitamin D requirements.

ULTRA-VIOLET LIGHT

Ultra-violet lamps can be purchased which produce biologically effective ultra-violet light. The effectiveness of these lights varies according to the construction, size, distance from the birds, and length of time used. The life of the light is limited, installation costs are high, and power consumption is high. Generally, they have to be operated for several hours to be effective.

Electric light bulbs can be secured which transmit some ultra-violet light. This method of supplying vitamin D is effective, but costly, and has not been used by poultry-keepers extensively.

MINERALS

Growing chickens, and laying hens in particular, require more mineral material than is found in ordinary feeds, especially those of vegetable origin. According to Wheeler,[4] the ordinary feed and water which hens receive supply only 15 per cent of the calcium necessary for egg shells.

Animal protein feeds are good sources of minerals. When vegetable protein concentrates are substituted for animal proteins, additional minerals need to be added. The minerals most needed are calcium, phosphorus, and sodium chloride. A lack of calcium is particularly important with laying hens, since their requirement is exceptionally high.

Kennard and Bethke[5] have summarized the situation in regard to minerals as follows: "There are 12 minerals generally considered essential to meet the requirements of poultry: calcium, phosphorus, chlorine, iodine, iron, sulphur, sodium, potassium, manganese, magnesium, copper and silica. Except for calcium, phosphorus, chlorine, and in rare instances iodine, the other minerals seem to be adequately provided by the common feedstuffs generally used in poultry rations."

Since the amounts in a poultry ration of some of the minerals, such as iodine, manganese, iron and copper mentioned above, are so small they are sometimes called "trace" minerals. Investigations show that any one of these minerals may be lacking in plants grown on soils depleted of their natural minerals. Replacement of deficient minerals in such soils not only increases crop yields, but corrects the lack of such minerals in the plants themselves.

MINERAL MIXTURES

The value of minerals has been greatly exploited in recent years and this has resulted in many mixtures of doubtful value being manufactured and put on the market. Usually they con-

[4] N. Y. Agr. Exp. Station.

[5] Ohio Bimonthly Bul. Mar.–Apr., 1936.

tain several minerals of unproven value together with those which are important. Such mixtures sell for high prices and may be uncertain in their effects.

There is some evidence which indicates that excessive amounts of minerals will affect the health of the birds and, in turn, the egg production. It is advisable, therefore, in adding supplementary minerals to rations to be guided by the results of reliable research or the advice of well qualified experts.

Bone meal is an important source of calcium and phosphorus for poultry. It is usually fed to furnish additional amounts of phosphorus in rations that would otherwise be deficient in these elements. When milk, meat scrap or fish meal is used as the main source of protein, it is usually unnecessary to add bone meal.

Bone meal is made from fresh bones of suitable quality which have been thoroughly cooked, dried and ground.

Limestone. High grade limestone suitable for poultry feeding purposes should contain 95 per cent or better of calcium carbonate and a low percentage of magnesium. Magnesium interferes with calcium assimilation. Two per cent ground limestone is often added to poultry mashes to supply the optimum amounts of calcium and phosphorus.

Limestone grit is used as a substitute for oyster shell for laying hens, but is not quite as palatable. White, shiny limestone grit is preferred to the dull gray products. Calcium content of limestone grit and oyster shell is about equal. The magnesium content should be low, as it is toxic to poultry.

Oyster shell is probably the best source of calcium for poultry. Ground oyster shell is used in mash mixtures and the crushed product is fed in separate containers as a supplement to the ration. A hen will eat from 2 to 4 pounds of oyster shell or limestone grit in a year, depending on the number of eggs produced.

Clam shells may be used as a substitute for oyster shells, but they are not assimilated as readily.

Salt. Small amounts of salt are desirable in a ration for poultry for palatability and digestion. Some feeds, such as grains and vegetable protein concentrates, are deficient while others contain a sufficient quantity. Excessive amounts of salt are toxic to poultry. From ½ to 1 per cent of salt is added to poultry mashes.

Extra amounts of salt are recommended as a control for cannibalism. (See page 496.)

Manganese is necessary in small amounts in some rations for proper bone formation and better hatchability. A lack of this mineral causes perosis, or slipped tendons. Only about 50 parts per million (¼ pound in a ton) are required in the mash part of the ration. Manganese is added in the form of manganese sulfate.

Charcoal. Charcoal may be fed, although recent scientific investigations show there is no advantage in the practice. It may absorb vitamins from the feed.

Grit should be supplied to poultry, not so much for minerals, but to furnish a means of pulverizing the food. Some investigators claim that hard non-calcium or insoluble grit is unnecessary when crushed oyster shell or limestone grit is available. For older growing birds and laying hens, both soluble and insoluble grits have proved satisfactory as grinding agents. Hard grit is more necessary with chicks since the calcium is usually included in the mash. With chicks, it promotes the development of the gizzard and prevents an abnormal thickening or swelling of the gizzard lining. Grit increases the amount of feed digested and, therefore, the economy of feed utilization.

SELECTING FEEDS FOR A RATION

Many factors besides the composition and chemical analysis must be considered in the selection of feeds for a ration.

Since poultry uses concentrated feeds to better advantage than any other live-stock on the farm, it is essential and more economical, in the end, to purchase clean wholesome feeds.

Musty, decayed, frozen or damaged feeds and those which contain weed seeds should be avoided as they are likely to upset the digestive system, check the egg production or growth and result in the death of some birds.

Palatability is an important factor in feeding. On it hinges the maximum intake of food, for it is safe to expect that hens will eat more of a food they relish. Maximum consumption is also necessary for the best egg production or growth. Palatability depends to a large extent on the mechanical condition of the feed. Very fibrous or sticky feeds are not likely to be eaten freely. Such feeds should be avoided or their use restricted.

Economy in feeding demands the selection of feeds which have a high degree of digestibility. Fortunately most of the feeds that are low in fiber and high in protein and nitrogen-free extract are highly digestible.

Variety is not as important as palatability, although it does tend to stimulate the appetite. Hens will do very well on a limited ration provided it is palatable and fulfills all their requirements. Greater variety in the ration, however, allows the feeder to make changes within it without affecting its palatability as much. Everything considered, a variety of feeds is more desirable.

A certain amount of bulk is necessary in the ration to distend the walls of the intestines and give the digestive juices a better opportunity to work. Bulky feeds like bran and ground oats and others, should be combined with more concentrated feeds such as middlings, corn-meal, and meat scraps to avoid stickiness and give the ration better consistency. When mixed with water the mash part of the ration should be crumbly.

Some feeds such as oil meal and wheat bran are laxative in their effect. Others like cottonseed feed and rice are constipating. The medicinal effect of feeds in worthy of consideration.

Some foods affect the color, flavor and odor of eggs and

meat. Yellow corn and the leaves of most plants, particularly legumes, will give a deep yellow color to the yolk of the egg, whereas wheat, oats, buckwheat, white corn and beets are inclined to give a lighter colored yolk. Large quantities of rape, turnips, fish scrap and sometimes cabbage may slightly affect the flavor of eggs and flesh. Onions and fresh fish are likely to injure the flavor of both eggs and meat so that they are unfit for use.

The local supply of feed must have an important consideration in preparing a ration. Grain grown nearby is usually cheaper and even though some of the local feeds may not be of the most desirable type, they can be blended with more desirable ones in such a way as to give good results. Buckwheat, kafir corn, soybean meal, rice, beans and others can often be used at considerable savings if the feeder knows how to appraise their value.

Probably the most important item to consider about each feed is its chemical composition. The composition of the common poultry feeds is shown in the appendix, in Tables 4, 5, 6.

DIETARY REQUIREMENTS FOR POULTRY RATIONS

The feeding requirements for poultry vary according to the age of the birds, the range, and purpose for which they are kept. The dietary requirements as they are known today are summarized in Table XXIII.

In making up a ration several different combinations of the most economical and available feeds should be tried using the dietary standards as a guide. It is well also to keep palatability, mechanical condition, variety, and other factors previously discussed in mind. After a few trials it should be possible to formulate a ration that will meet the requirements for which it is to be used.

Table XXIV shows how the protein, fiber, calcium, and vitamin A may be determined in a laying ration when 3 parts grain and 2 parts mash are fed. Other nutrients are found similarly.

HARMFUL PLANTS AND SEEDS

The following plants and seeds are said to be harmful to poultry: green potato sprouts, leaves of white snakeroot, milkweed sprouts, the green berries of black nightshade, and jimson weed seed.

TABLE XXIII

DIETARY REQUIREMENTS FOR POULTRY RATIONS

NUTRIENT	GROWING CHICKENS		LAYERS AND BREEDERS	
Protein	1-6 weeks 18-20% 6-12 " 16-18% 12 weeks on 14-16%		15-16%	
Phosphorus	.5-.8%		.7-.9%	
Calcium	1.0-1.5%		1.6-2 0%	
Manganese	30-50 P. P. M.*		50 P. P. M.*	
Fiber	4-8%		5-7%	
Fat	4-5%		4-5%	
	MINIMUM Required Per Pound	OPTIMUM Required Per Pound	MINIMUM Required Per Pound	OPTIMUM Required Per Pound
Vitamin A	1,350 U. S. P. units	2,000 U. S. P. units	1,800 U. S. P units	2,700 U. S. P. units
Vitamin B₁	575 micrograms	700 micrograms	Requirement has not been determined	Requirement has not been determined
Vitamin D	90 A O. A. C. units	180 A. O. A. C. units	270 A. O. A. C units	450 A. O. A. C. units
Riboflavin	1,350 micrograms	1,600 micrograms	1,000 micrograms	1,200 micrograms
Pantothenic acid	2,700 micrograms	3,200 micrograms	Requirement has not been determined	Requirement has not been determined

* Parts per million.

TABLE XXIV

GRAIN MIXTURE	CRUDE PROTEIN	CRUDE FIBER	N. F. EXTRACT AND FAT	CALCIUM	UNITS VITAMIN A
100 lbs. cracked corn	9.3	2.1	80.6	.01	318,000
100 " wheat	12.4	2.4	74.7	.04	14,000
200 " grain mixture	21 7	4.5	155.3	.05	332,000
100 " grain mixture	10.8	2 2	77.6	.025	166,000
MASH MIXTURE					
550 lbs. yellow corn meal	48.40	6.05	467.22	.055	1,749,000
400 " wheat flour middlings	68 00	20.40	278.60	.280	40,000
300 " wheat bran	46.80	27.00	173.60	.330	45,000
200 " ground oats, low fiber	22.40	22.60	141.20	.200	16,000
200 " soybean oil meal	87.80	11.80	84.70	.580	34,000
200 " meat scrap (55% protein)	110.40	4.40	50.20	16.500	......
100 " dehydrated alfalfa meal (17% protein)	20.40	17.10	45.90	1.900	9,500,000
40 " limestone	.....	.....	.....	15.680	......
10 " salt	.....	.....	.....	.....	......
2,000 " mash mixture	404.20	109.35	1,241.42	35.525	11,384,000
100 " mash mixture	20.2	5.4	62 0	1.77	569,200
300 " grain	32.4	6.6	232.8	.075	498,000
200 " mash	40.4	10.8	124.0	3.54	1,138,400
500 " of ration	72 8	17.4	356.8	3.615	1,636,400
100 " of ration	14.5	3.5	71.3	.723	327,280*

* One pound of the ration as fed contains 3,272.8 U. S. P. units of vitamin A.

XI. Feeding the Laying Stock

THERE are many successful rations for laying hens. The rations suggested here are recommended by the Poultry Department at Cornell University. The mash formula in Table

MASH

TABLE XXV

MASH MIXTURES FOR LAYING AND BREEDING HENS

INGREDIENTS	LAYING MASHES				BREEDER MASHES	
	No. 1	No. 2	No 3	No. 4	No 1	No. 2
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Yellow cornmeal	400	500	400	400	400	400
Flour wheat middlings	400	400	400	400	400	400
Wheat bran	400	300	400	400	400	300
Ground heavy oats	350	200	250	200	350	200
Alfalfa meal, low fiber	..	100	100	100	...	100
Dried skimmilk or dried buttermilk	100	...	50	100	200	...
Meat scrap (50 to 55 per cent protein)	300	200	200	150	200	200
Dried whey	...	50	...	...	...	150
Fish meal	...	..	150	...	...	...
Soybean oil meal	...	200	...	...	...	200
Corn gluten meal	...	...	...	200	...	...
Limestone or oyster-shell flour	40	40	40	40	40	40
Salt	10	10	10	10	10	10
Total	2,000	2,000	2,000	2,000	2,000	2,000
Manganese sulfate	4 ounces per ton					
Vitamin D from fish oil or activated animal sterols * when necessary.	900 A. O. A. C. units per pound †			900 A. O. A. C. units per pound †		
Protein %	19.8	19.7	21.0	19.9	18.7	20.1
Calcium %	2.1	2.0	2.2	1.6	1.8	1.8
Phosphorus %	1.1	.9	1.2	.9	1.1	1.0
Vitamin A units ‡ per pound	640	6,800	6,640	7,320	640	6,640
Riboflavin units per pound	1,570	1,635	1,795	1,910	1,935	2,040

* Since activated animal sterols are ordinarily not fortified with vitamin A, dehydrated alfalfa containing 75,000 or more units per pound should be used to ensure adequate vitamin A in the ration.

If the vitamin-D potency is expressed in units per gram, multiply it by 454 to obtain the number of units per pound.

Since about equal amounts of mash and grain are fed and the vitamin-D is included only in the mash, twice the amount of vitamin-D units is placed in the mash.

†To determine the amount of vitamin-D products to add to a ton of mash, see calculations on page 207.

‡Exclusive of vitamin A in fish oils, see Table XXIII (page 216) for requirements.

XXV are fed with equal amounts of grain by weight. Table XXVI gives grain mixtures that may be used with the mash formulas in Table XXV or Table XXVII. Table XXVII contains mash concentrate formulas of higher protein content.

GRAIN

TABLE XXVI

GRAIN MIXTURES FOR LAYING AND BREEDER RATIONS

Ingredients	Grain Mixtures				
	1	2	3	4	5
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Cracked or whole yellow corn	1,000	1,300	800	800	800
Wheat	1,000	700	800	800	800
Heavy oats	....	....	400	200	200
Barley	....	....	....	200	....
Buckwheat	....	....	....	....	200
Total	2,000	2,000	2,000	2,000	2,000

The grain portion of the ration may be fed as a mixture of two or more grains or separately.

Whole corn is somewhat more desirable than cracked corn because there are certain vitamin losses in cracking and because whole corn gives the feeder a better check on quality. Layers do not eat whole corn well unless taught to eat it on the range. Feeding whole corn saves the cost of cracking. It is not digested as rapidly, however, as cracked corn.

POULTRY-MASH CONCENTRATES

Poultry-mash concentrates are being used to some extent by those farmers who wish to make use of home-grown grains. A number of commercial concentrate mixtures are available. The proportion of home-grown grains that may be combined with a concentrate may be varied considerably. Because grains are low-protein feeds and are deficient in many of the other essential substances, a poultry-mash concentrate must contain more protein than an ordinary mash and also more of the vitamins. When mixed with ground grains in the proportions indi-

cated, the resulting mash mixture will be similar to the regular mashes in Table XXV. Any of the grain mixtures indicated in Table XXVI can be ground and mixed with the concentrates.

Suggested mixtures for poultry-mash concentrates are given in Table XXVII. The formulas in Table XXVII can also be used when whole grain is fed unrestricted in hoppers. When fed in this manner the amount of vitamin D added to the mash will depend on the ratio of mash consumed to grain. In some

TABLE XXVII

POULTRY-MASH CONCENTRATES

Ingredients	Breeder Mash	Laying Mashes 1	Laying Mashes 2
	Pounds	*Pounds*	*Pounds*
Wheat bran	200	300	200
Soybean oil meal	400	600	500
Meat scrap (55 per cent protein)	600	600	700
Dried whey	400	...	120
Dehydrated alfalfa meal (17 per cent protein)	220	320	300
Pulverized limestone	120	120	120
Salt	60	60	60
Total	2,000	2,000	2,000
Manganese sulfate	20 ounces per ton	....	
Vitamin D from fish oil or activated animal sterols *	(5 x 450) 2,250 A. O. A. C. units per pound †	(6 x 450) 2,700 A. O. A. C. units per pound †	
Mixing proportions:			
Ground grains	3	2	
Concentrates	2	1	
Protein %	31.4	30.1	35.4
Calcium %	5.9	5.1	5.6
Phosphorus %	1.5	1.6	1.7
Vitamin A units ‡ per lb.	13,200	19,200	18,000
Riboflavin units per lb.	4,090	2,720	3,235

* Since activated animal sterols are ordinarily not fortified with vitamin A, dehydrated alfalfa containing 75,000 or more units per pound should be used to ensure adequate vitamin A in the ration.

If the vitamin-D potency is expressed in units per gram, multiply this by 454 to obtain the number of units per pound.

† To determine the amount of vitamin-D product to add to a ton of mash, refer to the calculations on page 207.

‡ Exclusive of vitamin A in fish oils, see Table XXIII (page 216) for requirements.

experimental flocks five times as much grain was consumed as mash concentrate, consequently five times as much vitamin D should be added to the mash mixture (5 x 450 A. O. A. C. units) as is required in the diet of the laying hen. The same principle applies to the addition of manganese sulfate in a ration for breeders.

TABLE XXVIII

ALL-MASH FORMULAS FOR LAYING AND BREEDING HENS

INGREDIENTS	No 1	No. 2	No. 3
Corn meal	900	700	810
Flour wheat middlings	400	200	400
Wheat bran	200	200	200
Ground wheat	..	400	..
Ground oats	200	200	200
Dehydrated alfalfa meal (17 per cent protein)	50	50	50
Meat scraps (55 per cent protein)	150	150	50
Dried skimmilk or buttermilk	50	50	.
Dried whey	..	.	50
Soybean meal	...		150
Steamed bone meal	...	. .	20
Limestone or oyster-shell flour	40	40	60
Salt	10	10	10
Total	2,000	2,000	2,000
Manganese sulfate	4 ounces per ton when fed to breeders		
Vitamin D from fish oil or activated sterols * when necessary	450 A. O. A. C. units per pound for layers and breeders †		
Protein %	15.3	15.2	15.0
Calcium %	1.51	1.50	1.81
Phosphorus %	.76	.74	.74
Vitamin A units ‡ per pound	1,470	1,150	1,326
Riboflavin units per pound	12,750	12,375	12,050

* Since activated animal sterols are ordinarily not fortified with vitamin A, dehydrated alfalfa containing 75,000 or more units per pound should be used to ensure adequate vitamin A in the ration. If the vitamin-D potency is expressed in units per gram, multiply this by 454 to obtain the number of units per pound.

† To determine the amount of vitamin-D product to add to a ton of mash, refer to the calculations on page 207.

‡ Exclusive of vitamin A in fish oils, see Table XXIII (page 216) for requirements.

METHODS OF FEEDING

Having selected a ration the next step is how to feed it. There are many successful methods or systems in use. No one of them can be definitely given as the best under the many

conditions that exist. Factors which might influence the choice of a method are: (1) the amount of labor required and its cost, (2) the amount of skill required by the feeder, (3) cost and amount of feed consumed, and (4) the results in egg production or hatchability. It is advisable to select the ration and method carefully and make changes *during the laying year* only when absolutely necessary. In all modern methods of feeding laying hens, the mash is usually supplied in hoppers or feeders before the birds at all times. Consequently the differences in feeding practices are largely in the way in which grain is fed. With this in mind—the methods most commonly in use may be classified as follows: (1) hand feeding of grain, (2) limited hopper feeding of grain, (3) unlimited hopper feeding of grain (free choice), and (4) all mash.

Whatever method is followed, a sufficient daily intake of feed is *very important*. The feeder should not forget that most of the feed consumed by laying hens and all the feed for growing chickens is for body maintenance. With laying hens there must be more than enough to meet maintenance needs before egg production can be carried on regularly and to the highest degree. The aim of the feeder therefore should be to secure as high an intake of feed as possible. If the birds have the inheritance, health and proper surroundings it will result in the greatest possible feed efficiency and production. The average hen will eat from 70 to 100 pounds of feed in a year. About 60 to 75 pounds of this feed is required for maintenance.

Birds like the Leghorn averaging 4 pounds in weight require about 18 to 19 pounds of total feed per 100 birds daily for body maintenance. When egg production starts, approximately one more pound of feed a day is needed for 100 birds for each 10 per cent increase in egg production. At this rate 100 Leghorns laying 70 per cent will require about 26 pounds of total feed daily. That the total daily mash and grain consumption is closely associated with the number of eggs laid is borne out in practice. The watchful feeder knows that a drop of only a

pound or two of feed a day per 100 birds, or ¼ of an ounce per bird, if persistent will result in a drop in egg production within a few days. The skill of a poultryman is often indicated by his ability to avoid slumps in production by getting his birds to consume large quantities of feed regularly.

The following table gives the estimated total amounts of feed required for maintenance by White Leghorns and heavy breeds at different levels of egg production.

TABLE XXIX

DAILY FEED REQUIREMENTS FOR 100 LAYING HENS

Per cent Production	Feed Required for 100 Layers for 24 Hours	
	Leghorns	Plymouth Rocks or Rhode Island Reds
	(Pounds)	*(Pounds)*
0	19	22
10	20	23
20	21	24
30	22	25
40	23	26
50	24	27
60	25	28
70	26	29
80	28	30

HAND FEEDING OF GRAIN

This is the oldest and most common method of feeding laying hens. The grain is fed by hand in the litter and in troughs. The amount of grain fed depends upon the protein content of the mash. Most poultrymen aim to feed about equal amounts of grain and mash by weight when the mash runs from 18½ to 21 per cent protein. See Table XXV. Since the average grain mixture has about 11 to 12 per cent protein, this gives a protein level of about 15 per cent for the total feed consumed, which is the amount recommended for best results in egg production, maintenance of body weight, egg size, and hatchability.

Since the birds prefer grain, it becomes necessary for the

feeder to manage this part of the ration in such a way as to encourage mash consumption without reducing the total intake. This requires close attention and skill.

The amount of grain to be fed varies with the size of the birds, the percentage of production, the season, palatability of the mash, and the condition of the birds. For White Leghorns and similar breeds it varies from 9 to 13 pounds a day for 100 birds and from 11 to 16 pounds for the same number of the heavy breeds. The maximum amount is more likely to be fed in the winter, when the birds' need for body-warming material is greatest especially if production is high.

As a rule, not more than one-third or one-fourth of the daily allowance of grain is fed in the morning. Sometimes none is fed. This encourages mash consumption during the day. Feeding grain in deep litter induces the birds to exercise and this tends to increase food intake. It also helps to keep the litter dry through constant stirring.

In cold weather it is often advisable to give layers a small amount of grain (from a pint to a quart to 100 birds) at noon to increase their activity and the intake of feed, which is likely to be down on very cold days.

The balance of the grain is given early enough in the afternoon so that the birds will have plenty of time to eat their fill before dark unless evening lights are used. In that case, the grain is fed about two hours before the lights are turned off. It is good practice to try to feed as nearly as possible just what the hens will clean up. If a little remains it will do no harm, as it will be picked up in the morning. However, if much remains it is an indication of overfeeding and the amount of the night feeding should be reduced.

One way to find out how much grain hens will eat at night is to feed it occasionally in troughs. With hand feeding it is customary to feed mixtures of grain rather than to feed certain grains separately. In addition to mash, clean water, grit and crushed oyster shell or limestone should always be available.

Hand feeding of grain requires the most skill. The problem of the feeder is to watch the intake constantly and make adjustments in feeding which will ensure the highest possible consumption. Good judgment is necessary to do this and maintain a satisfactory balance between grain and mash. The ration used with this method is usually cheaper than an all-mash ration because it is unnecessary to grind or mix part of the feed.

LIMITED HOPPER FEEDING OF GRAIN

This method of feeding consists in placing the various grains separately or as a mixture in troughs or feeders which can be closed or covered. Except in winter, when a pint or a quart of grain for each 100 birds may be thrown in the litter to induce them to exercise, access to grain is permitted only for two or three hours in the afternoon, just before roosting time. After the birds go to roost the feeders are closed until feeding time the next day.

Enough separate grain feeders should be available so that a large part of the birds can eat at one time. Double-deck trough feeders (see Fig. 37) are well suited for this purpose. Mash is fed in the upper trough, grain in the lower one. One double-deck feeder 6 feet long is the minimum space for 50 birds, three 5-ft. feeders are none too much for 100 birds. Instead of the double-deck feeder, grain feeders with a cover may be located along the side walls of the pen and the customary mash feeders may be used. Since with this arrangement the birds can eat only from one side, 12 linear feet of feeding space should be allowed for 50 birds.

This method of managing the grain feeding encourages maximum consumption of mash. The amount of mash consumed can also be regulated by the length of time the grain feeders are left open. The amount of grain to feed day by day is no problem, as the birds decide this. Furthermore, each bird has a better chance to eat what it wants in amounts and kinds of feed. This is particularly true when grains are fed separately,

as the likes and dislikes of individual birds for certain grains vary considerably. This assures maximum intake of total feed.

Clean water, grit and crushed oyster shell or limestone should always be available.

The usual mash mixtures given in Table XXV, with a protein content of about 20 per cent, are used with this plan of feeding. About equal parts of grain and mash are consumed.

This method of feeding grain requires less skill than hand feeding. It has been in use on the Cornell Experimental Farm for several years and has given excellent results.

UNLIMITED GRAIN FEEDING (FREE CHOICE)

This method of feeding is sometimes called "cafeteria" feeding because both the mash and the grain, mixed or separately, are before the birds all the time where they can help themselves without restriction.

It is essential that ample feeding space for both grain and mash be provided the same as has been stated for limited grain feeding.

High-protein mashes as suggested in Table XXVII or the more common 20-per-cent mashes in Table XXV may be used. The birds will eat from two to four times as much grain as mash, depending on the protein content of the mash and the rate of production. Tests show that as the protein content of the mash is increased, the percentage of grain consumed also increases. Observations show that the birds tend to sense their requirements of protein and govern their consumption of mash accordingly. Some of the feeds in high-protein mashes are not as palatable and this may discourage consumption. Since the birds prefer grain, special inducements may have to be used to encourage mash consumption. This can be done by adding fresh mash once or more daily, frequent stirring, and placing the hoppers in well-lighted positions.

Since the mineral and vitamin supplements to poultry rations are usually placed in the mash part of the ration, there is dan-

ger of a deficiency of these nutrients with low mash consumption. This is more likely to happen if ordinary mash mixtures are used unless steps are taken to include these nutrients. This is particularly true of vitamin D. This can be overcome by adding larger amounts of fish oils or other vitamin-D carriers to the dry mash or by mixing it daily with wet mash or on the grain.

Studies of the individual nutritive requirements of hens have shown wide variations in their requirements for protein, minerals, vitamins and other nutrients. It is customary to make up rations to meet the average requirements of birds, consequently the supply of nutrients may be high for some birds in the flock and low for others. The free-choice system of feeding permits the birds to balance the ration more nearly according to their individual needs. This method can be used successfully with White Leghorns as well as with the heavy breeds. Mortality is no greater with this system than with any other.

With free-choice feeding, inheritance of production is important. Birds that are not bred to lay are more inclined to get fat and quit laying. Some say this is an advantage as it is easier to tell the poor producers and they are already in good condition to go to market.

Unlimited grain feeding is economical of labor, is convenient, and there may be a small saving in feed cost since a large proportion of the ration is whole grain. Such a ration is particularly well adapted to the poultry-keeper who grows his own grain. Little skill is required in free-choice feeding.

ALL-MASH FEEDING

As the name implies, this consists in feeding all the feed in the form of mash. This method requires the least skill and consists mostly in keeping the feeders supplied. There is possibly some saving in labor.

There is more uniformity of yolk color than with other methods since all the birds eat the same kind of feed. All-mash is

generally more expensive, as all the feed has to be ground. However, it is a satisfactory method of feeding hens in batteries.

All-mash feeding results in larger water consumption. It also creates a little problem as there is no inducement for the birds to scratch in the litter and this soon packs down.

Better feed consumption is secured when part of the mash is fed as wet mash or pellets, probably because there is less variety in the diet. Besides, the mash is less palatable than grain.

Grit, crushed oyster shell or limestone should be supplied in separate containers. An abundant water supply is important, as the ground dry feed makes the birds more thirsty than usual.

Comparative experiments with other methods of feeding at some of the state experimental stations show that the all-mash method of feeding may not give quite as good results in egg production.

SUPPLEMENTS TO THE RATION

Wet mash. Laying mash moistened with milk or water is a valuable aid in holding or increasing feed consumption when such stimulation is necessary. Wet mash is much more palatable than dry mash if properly prepared. It should be neither too dry nor too wet. If anything, it is better to have it a little too wet, but the best consistency is one where a ball of the wet mash will break into pieces when dropped on a board.

Wet-mash feeding is valuable on very cold days when the feed consumption is below normal. It can be discontinued without harmful effects after the cold snap is over and consumption is normal.

Wet mash is often fed during the summer and fall to maintain feed consumption and egg production. It is helpful in bringing pullets into production and in building up hens which have been thrown out of production due to disease or to other

causes. If wet mash is fed regularly to a flock it should not be discontinued abruptly. A sudden stop in wet mash is likely to result in a drop in feed consumption and this in turn may bring on a molt with a drop in egg production.

An easy way to feed moist mash is to pour milk or water carefully and slowly over the top of the mash in the feeders. About 2 quarts of liquid is needed for 100 birds. Mixing is unnecessary. Care must be taken, when this method is used, to see that all the moistened mash is consumed daily, as otherwise it will sour or become moldy.

Noon is considered the best time to feed wet mash although good results were obtained on the Cornell Experimental Farm when it was fed just before the night feeding of grain. The quantity fed should be about what will be eaten in twenty to thirty minutes. Wet mash may be fed several times a day but this of course requires much more labor.

Wet mash may be fed any time of day when the free-choice method of feeding grain and mash is used.

Pellets. Pellets are small amounts of dry mash compressed under high pressure into a solid condition. Pellets have been used in place of dry mash but comparative results show no particular advantages in this way. The cost of pellets is slightly more than that of mash, due to the processing. The best use of pellets is as a supplementary feed in place of or in addition to wet mash to increase feed consumption. Pellets are made of the regular dry-mash mixture or fattening mixtures. The latter has a protein content about like that of grain and may replace grain. The chief advantage of pellets is the ease with which they are fed as compared with wet mash.

Green feed. Limited amounts of tender leafy green feed may act as a stimulant to the appetite and increase the feed consumption. They are a valuable addition to the ration because they supplement the vitamin supply.

Leafy green feeds like kale, rape, and swiss chard may be fed as they are cut, but alfalfa clover or grass should be finely

chopped before feeding to prevent the birds' becoming crop-bound from the long stems. The grass and clover should be less than six inches high to have the highest food value. The best time to cut and feed such green feeds is in the morning, when the plants are fresh with dew. Not more than five pounds of such green feed should be fed to 100 birds daily, as unlimited amounts give the eggs too deep a yolk color and decrease mash and grain consumption.

Minerals. Grit and crushed oyster shell or limestone should be kept in hoppers before the birds at all times. Charcoal and mineral mixtures are unnecessary. Salt is fed in the mash. Manganese sulfate is included in the ration for breeders.

Water. A fresh clean supply of water should be available at all times, but particularly the first thing in the morning and the last thing at night. In winter, the water containers should never be allowed to freeze for this cuts down the water consumption and quickly affects the egg production. Where electricity is available, electric water heaters of various types, some automatically controlled, can be used to keep the water temperature from dropping below 40° F. For places without electricity, large fountains with a lamp underneath to supply heat can be used. They are comparatively safe.

Hens appreciate frequent changes of water in summer, and for this reason running water is preferred.

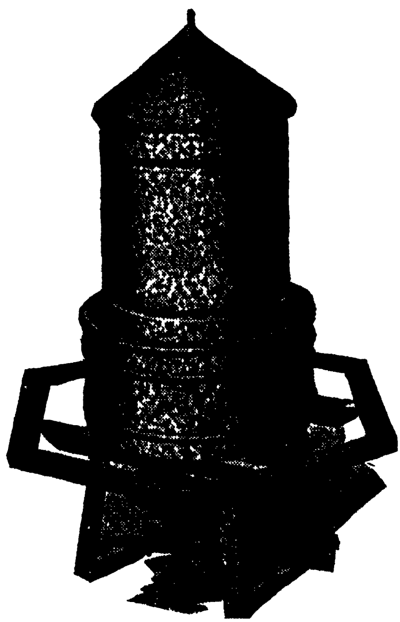


Fig. 84. An eight-gallon drinking fountain equipped with a kerosene oil lamp in the base to keep the water from freezing.

The water requirement of hens is twice as great per unit of body weight as for other farm animals.

The water consumption varies with the rate of laying, temperature and humidity of the air, temperature of the water, and consumption of dry mash, wet mash and green feed.

Fig. 85. A cartridge type electric water warmer. (Jamesway Mfg. Co.) This electric warmer is placed in the poultry drinking water. The temperature of the water is controlled by a thermostat in the heater. (Courtesy of C. N. Turner, Agr. Eng. Dept., Cornell University.)

The minimum requirement of 100 Leghorn fowl is probably 10 quarts daily; maximum, 23 to 25 quarts.

Next to air, water is the most common, the most readily supplied, and often the most inexpensive element which most poultry-keepers can give their hens, yet the supply is often neglected. Water is just as important, however, as feed, and probably more so for a hen can live longer without feed than without water.

Removing the water supply from a laying flock for one day will result in an immediate drop in egg production followed by a molt.

Milk products. Milk or buttermilk, whether in liquid, condensed or dry form, is one of the best supplements to a ration if it is available on the farm or can be purchased for a mod-

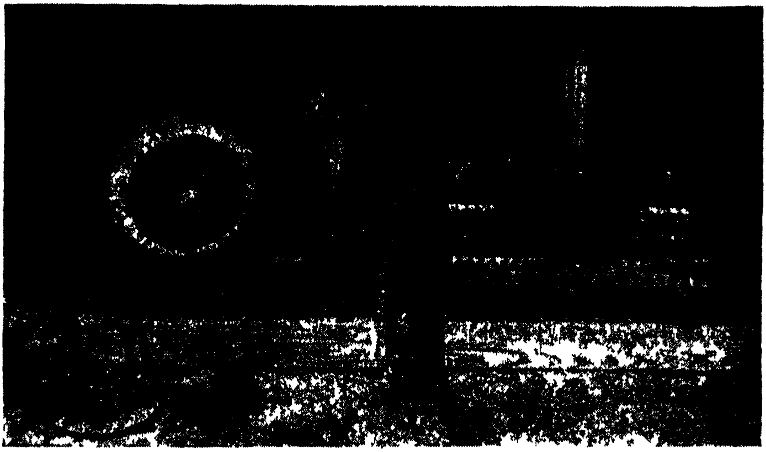


Fig. 86. Electric water warmers which can be made at home. (Courtesy of Agr. Eng. Dept., Cornell University.)

erate price. Milk is valuable for its protein, minerals and vitamins. Skimmilk or buttermilk may be fed as a drink either in addition to or in place of water. Both may also be used in place of some other protein concentrate in the mash. From 12 to 14 quarts are allowed for 100 hens daily. When liquid skimmilk is available and is fed with water, the meat scrap in the mash may be reduced at least one half.

Condensed buttermilk can be used in paste form as it comes from the container, or as a liquid by adding 1 gallon of water for each pound of condensed milk. It is customary to feed about 2 pounds of buttermilk for each 100 hens daily. When so used, the dried milk in the mash may be omitted.

A thick creamy mixture of condensed milk and water is often used in moistening dry mash. This is the best way of feeding condensed milk, as it not only makes the wet mash more palatable, but distributes the milk evenly so that each

bird in the flock has a better chance to get its full share readily.

One gallon of liquid skimmilk or buttermilk is equal to about 3 pounds of condensed-milk products, or 9 pounds of dried skimmilk or buttermilk, in feeding value.

CHANGES IN FEEDING

Hens are creatures of habit and register their disapproval of a change very quickly by lowered production. All substitutions or changes in rations and in methods of feeding should therefore be made gradually. Even a change of feeders is sometimes followed by a drop in egg production.

FEEDING HENS AND PULLETS

The underlying principles of feeding remain the same when artificial illumination is used, but the time of feeding must be arranged to fit the working hours of the birds. (See Chapter XIII, page 259.)

FEEDING PULLETS

Just as soon as the pullets show by their size and comb development that they are about ready to lay, they should be removed to winter quarters. A change of location after they have begun to lay may check laying and start a molt. Once housed they should not be let out again until spring. By keeping them in, it is much easier to train them to eat the proper amounts of feed.

One of the first duties of the feeder after the birds are housed is to encourage maximum consumption of feed. This is done best by hopper-feeding both grain and mash for the first few weeks. Later, after the birds have become accustomed to their surroundings and are eating well, adjustments in the method of feeding may be put into effect. By handling the feeding in this way, consumption is likely to be less affected by the change especially if both grain and mash have been hopper-fed on the range.

Laying mash should be substituted for the growing mash a short time before the birds are moved into the laying pens. If pullets are slow in coming into production, it may be ad-

Fig. 87. A floor mash and grain feeder. Many poultry keepers prefer a feeder of this type as consumption of feed seems to be better, although litter may be scratched into the feed. (Courtesy of John H. Vondell, Massachusetts State College.)

visable to limit the grain to encourage greater mash consumption. Leghorns should start to lay when 5 to 6 months old, and general-purpose breeds when 6 to 7 months old.

The production of late-hatched or poorly reared pullets may

be hastened by feeding wet mash once or twice a day and by using artificial illumination.

Unless very skillfully handled, pullets that begin to lay in the summer will drop off in production and molt early in the winter. Such birds should be watched carefully and at the first indications of a decline in production artificial lights should be started. Usually this drop in production is associated with a decline in feed consumption and body weight. In order to have a check on the condition of their birds, some feeders mark a few pullets and weigh them regularly. If the birds show that they are consistently losing weight, steps should be taken to increase the feed intake. If the use of artificial illumination does not stimulate feed consumption and prevent a slump, wet mash, pellets, or liquid milk, or all of these, should be fed in addition to the use of light.

On extremely cold days in winter the total feed consumption generally falls off and this is followed by a drop in egg production. Warm wet mashes and other appetizing feeds on such days will tend to maintain a more even intake of feed and help to sustain production.

FEEDING HENS IN SUMMER AND FALL

It is natural for hens to produce well during the winter and spring if they are well cared for. Later, when the weather begins to get warmer (about July 1st in the latitude of New York State), there is often a falling-off in production which may become quite serious if the feeding is not carefully watched. Of course other management factors, such as poor ventilation, lack of feeder space, the presence of red mites and lice, and the like, may contribute to this condition and should be corrected if found to be a factor in the situation.

When the first indications of the decline appear, it is advisable to begin feeding wet mash, pellets, or milk in liquid or condensed form in addition to the regular ration. From 3 to 5

pounds of fresh, leafy green feed such as rape, cabbage or finely cut grass or clover will help to stimulate the appetite of the birds. Later, about the middle of August when the days begin to get shorter, one or two hours of artificial light may be used. It is possible by these means, without injury to the hens, to keep the best layers producing until late in the fall.

FORCING THE MOLT

In some states forced molting is advocated during the summer months when egg prices are lower. It is planned to have the birds over the molt and back in production early in the fall when egg prices are high. To accomplish this the mash is removed and the birds are given grain and water for two or three weeks. If this does not check production completely and bring on a molt, the drinking water is withheld for one day. This usually brings about the desired results.

Molted hens lay larger eggs than do pullets, and production during the fall months is likely to be higher than from hens on a normal program of management. Results have been variable in different parts of the country. In the state of Washington forced molting has become an established practice, but in the eastern part of the United States it is considered a questionable practice.

HOT-WEATHER FEEDING

The feed consumption of laying birds is likely to fall off as much as 20 per cent during extremely warm weather in summer. This is generally followed by a drop in egg production. Providing fresh cold water several times during the day, ample ventilation, sprinkling the floor and sidewalls with water in extremely hot weather, and feeding wet mashes, are helpful in keeping up feed consumption at such times.

FEEDING AND MANAGEMENT OF BREEDERS

The ration and the method of feeding for breeders are practically the same as for the laying flock. It does not injure hens

for breeding purposes to lay in the fall previous to the breeding season, provided they are given a complete rest period of at least eight weeks before they begin to lay again, and are fed a ration which includes all the necessary nutrients to make them healthy and vigorous. In fact it is good business to keep the breeders laying until November. It is not advisable to stimulate production too late in the fall, for the hens should have time to molt before the really cold weather sets in, otherwise they suffer from the cold and a few may die. Production can be stopped at any time by discontinuing the supplementing feeds and artificial illumination.

When production ceases or is checked in the fall, both grain and mash may be hopper-fed while the birds are molting. The ration should contain ample amounts of riboflavin-carrying feeds such as alfalfa or milk and its by-products. Manganese sulfate should also be added to the ration. Production should not be encouraged until about a month before eggs are needed for hatching.

When it is possible, the breeders should be given access to a good grass-covered range.

SLUMPS IN EGG PRODUCTION

Most slumps in egg production which occur in a laying flock during the year are primarily caused by lowered feed consumption. Unfavorable environment and management on the part of the caretaker are contributing factors. The principal causes of slumps are:

1. Violent changes in weather.
2. Changes in the ration.
3. Changing birds from one pen or house to another.
4. A ration with too low protein level; 15 per cent is desirable.
5. Irregular use of light.
6. Fright due to rough handling.
7. Insufficient feed.
8. Lack of feeder space.

9. An inadequate or irregular water supply.
10. An inherited factor called *winter pause.*
11. Poor ventilation which results in a cold uncomfortable place to live in.
12. Disease.
13. Heavy infestations of worms, lice or mites.
14. A change in caretakers.
15. Poor production by inheritance.

FEEDING BROODY HENS

Broody hens should be removed promptly from the nest as soon as noticed (after dark generally), and confined in a light well-ventilated broody coop ·They should have plenty of the regular laying mash, preferably wet, and water, but no grain.

XII. Vitamins

IN A MODERN ration for poultry the vitamin content of feeds must be given careful consideration. Vitamins are organic chemical compounds which occur in feeds in very small amounts. As has been stated previously, their presence is absolutely necessary in feeds to promote normal growth, egg production, and health, and to prevent sterility.

For a long time after the naming of the first vitamin by Casmir Funk, a Polish chemist, in 1911, the exact nature of vitamins was unknown. Funk called the crystalline product which he isolated from rice polishings a "vita-amine," since he believed it belonged to a chemical compound containing nitrogen which was necessary for life. Later the name was generally accepted but the final letter was omitted, leaving the word vitamin.

The different vitamins were first distinguished by observing the effect of rations deficient in one of them on rats, guinea pigs, pigeons, chickens, and other animals. Several vitamins have recently been isolated by chemical means and they can now be distinguished by chemical and physical, as well as by biological, effects.

The vitamin content of different feeds is determined for the most part by feeding tests. The feed to be tested is fed to several lots of chickens or rats as a supplement to a basal ration known to be complete except for the vitamin under consideration. Results are noted in the rate of growth, health, and reproduction of the chickens or animals. Almost all the common feeds have been tested in this way, so that the feeder can now compare the vitamin content of different feeds. The amount of certain vitamins may also be measured by chemical and physical methods. Some of the vitamins are produced in the body;

many are stored in the body, especially in the glandular organs, and in the egg.

Green plant tissue is, with few exceptions, one of the best sources of all the vitamins known except D.

KINDS OF VITAMINS

More than a dozen vitamins are known to be necessary for poultry. There are many more that have been reported but not confirmed. They are usually divided into two groups: the fat-soluble vitamins which are soluble only in fats; and the water-soluble vitamins which are soluble in water. The first vitamins discovered were designated by letter; but some of the more recent ones have received descriptive names, and still others have been renamed as their chemical make-up became known and a chemically descriptive name was possible.

The fat-soluble vitamins are A, D, E, K, and the anti-gizzard-erosion factor. The water-soluble vitamins include B, C, G (riboflavin), B_6, H, and pantothenic acid. The newer factors R and S (Cornell) and U (California) are also water-soluble.

Vitamins A, D, and G are most important in the diet of poultry, and a shortage of any one of them quickly manifests itself in the growing flock. They also affect the maintenance of body weight, egg production and hatchability in hens.

VITAMIN A

Proper amounts of vitamin A in the diet of poultry preserve the health of the eyes, promote normal growth and health, stimulate the appetite, aid digestion, and increase the resistance to diseases and parasites. This vitamin is necessary for good fertility and hatchability, and for the normal functioning of epithelium of the respiratory organs and nerve tissues.

Because a deficiency of vitamin A affects the eyes, it is called the anti-ophthalmic vitamin. When a serious deficiency of this vitamin occurs, it causes the secretions of tear, salivary, and

intestinal mucus glands to dry up. The edges of the eyelids become granular. Infection may occur which produces a viscous fluid that causes the eyelids to stick together. This disease is

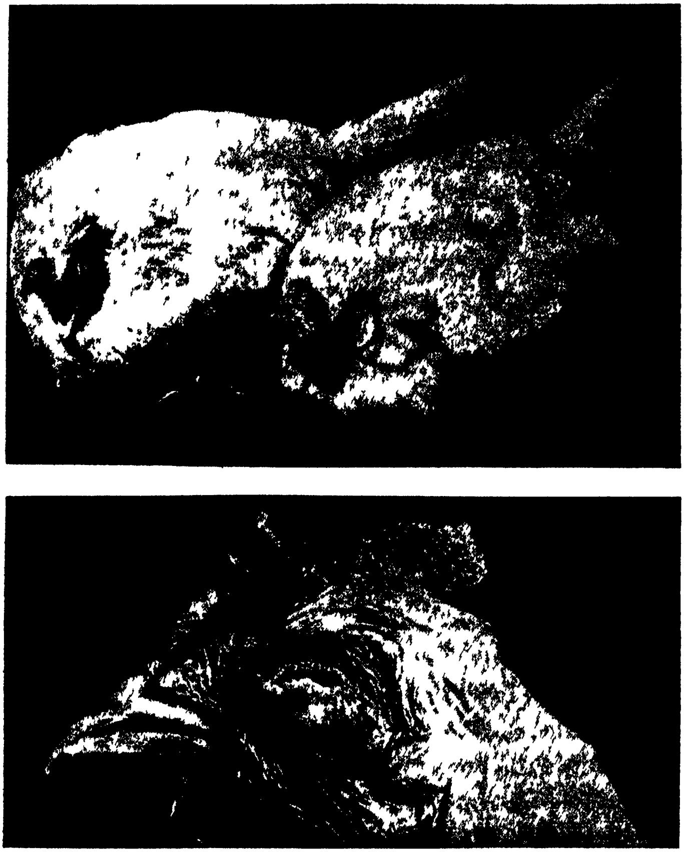


Fig. 88. The characteristic ophthalmia of vitamin A deficiency. (University of California.)

called ***xerophthalmia,*** or "nutritional roup." It is distinguished from ordinary roup by the lack of the customary nauseating odor.

Further symptoms include slow growth among growing

chickens and cessation of production with hens, paleness of shanks and beak, drowsiness, staggering gait, paralysis, incoordinated movements, a tendency to remain in a sitting position for long periods, emaciation, weakness, and finally death.

Upon autopsy, characteristic vitamin-A deficiency shows creamy white postules in the roof of the mouth and along the esophagus. An excess amount of urates may be deposited in the kidneys so that these organs enlarge and appear grayish in color. The gall bladder and the proventriculus are enlarged.

REQUIREMENTS OF POULTRY FOR VITAMIN A

The minimum requirement for chicks which just protects against deficiency symptoms is 1,350 U. S. P. units per pound of the ration. Taking into account the instability of the vitamin and variation in the amount in feedstuffs, a better margin of safety is provided when 2,000 or more U. S. P. units are maintained. Vitamin A is the only one for which the requirement increases with the age of the bird.

The minimum requirement for laying and breeding hens is 1,800 U. S. P. units, or nearly twice that for chicks. However, the optimum amount for best results and to ensure the transfer of vitamin A to the egg, is 2,700 U. S. P. units per pound of the ration. (See Table 8 in the appendix for the vitamin-A content of various feedstuffs.)

Vitamin A is a thick colorless compound found only in fatty animal tissue. Its chemical formula is $C_{20}H_{30}O$, but thus far it has not been given a name.

Vitamin A can be formed in the body of the animal from carotene and other carotinoid pigments supplied in the food. Compounds that may be transformed into vitamins by the animal are known as vitamin precursors, or provitamins.

The conversion of carotene into vitamin A takes place chiefly in the liver. When an animal receives an abundant supply of vitamin A or carotene in its food, it stores vitamin A in the liver and, to a less degree, in the fat tissues of the body. Simi-

larly, unchanged carotene may be stored in the body. Vitamin A is also stored in the egg, but the amount depends upon the quantity in the food.

Both carotene and vitamin A are readily destroyed by prolonged heat and exposure to air. On account of this a great loss of vitamin-A value may take place in the making of hay from green forage under field conditions. This explains why the shorter dehydrating process which retains the color of the plants usually produces a product higher in vitamin content. A considerable loss in vitamin A also takes place when hay or feed is stored for a long period, especially at high temperatures.

The best source of true vitamin A is in certain fish-liver oils, such as cod, halibut, shark, tuna, etc.

Carotenes are plant sources of vitamin A. They are yellow fat-soluble pigments found in green plants, dried grasses, alfalfa, grass silage, yellow corn, carrots, and sweet potatoes. There are four of these carotenes. They are known as alpha, beta, gamma, and hydroxy-beta carotene, or kryptoxanthine. Beta carotene is the most important. It has twice the vitamin-A potency of the others. It is found in all green leaves together with other yellow pigments and the green pigment chlorophyll. In general, the green coloring provides a way of judging the vitamin-A potency of forage because of its close association with beta carotene. Practically all the vitamin-A potency of forage crops consists of beta carotene.

The International and U. S. P. (United States Pharmacopeia) unit of vitamin A is .0006 milligram of pure beta carotene.

In referring to the vitamin-A content of a feedstuff, it is customary to disregard whether its value is due to carotene or to true vitamin A.

VITAMIN B (B_1)

An adequate supply of vitamin B is necessary to preserve the health of the nervous tissue and for the proper mainte-

nance of appetite. Because a lack of this vitamin affects the nervous system it is sometimes called the anti-neuritic vitamin. Its chemical name is thiamin.

A lack of vitamin B in the diet is accompanied by loss of appetite, emaciation, general weakness, paralysis, and finally death (Fig. 89). This is known as beriberi in humans and as polyneuritis in poultry. There should be little trouble with a lack of vitamin B if a well-balanced ration is fed, as it is the most widely distributed of all vitamins. It is not easily destroyed.

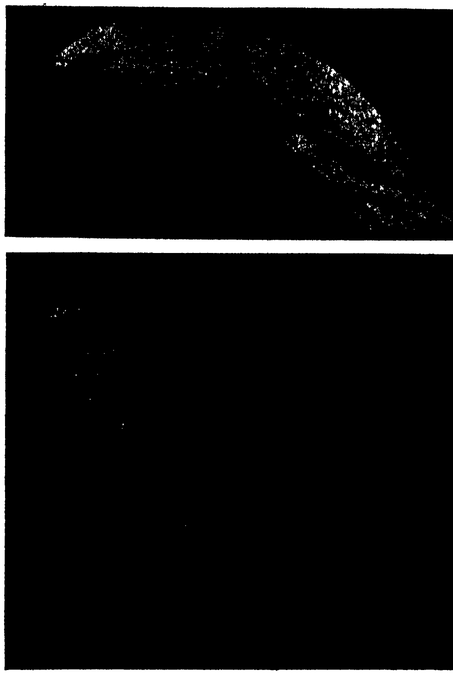


Fig. 89. Above, result of feeding a ration deficient in vitamin B. Below, the same bird one week later, after being dosed with wheat-germ extract. (Poultry Dept., Cornell University.)

The minimum requirement of vitamin B for growing chickens is 575 micrograms of thiamin per pound of feed. For safety an optimum level of 700 micrograms is advisable. Amounts for adult birds have not been determined. One international unit is equivalent to 3 micrograms, or 3 millionths of a gram, of pure crystalline thiamin for rat growth.

Vitamin B is found in fairly large amounts in all unprocessed cereals, particularly in the germ, in green plants and vegetables, in liquid or dried milk, and in large amounts in yeast. Except in few instances, the addition of yeast—although rich in vitamin B—does not improve most rations.

VITAMIN C

Water-soluble C, or the anti-scorbutic vitamin, is found in fresh vegetables, milk, and such fruits as oranges and lemons. Absence of vitamin C causes scurvy in humans and some animals. Poultry, swine, and cattle are able to make their own vitamin C and, for this reason, do not need to have special amounts supplied in their food. Vitamin C is very easily destroyed, especially when the food in which it occurs is heated.

VITAMIN B_6 (PYRIDOXINE)

Vitamin B_6 (pyridoxine) is a white crystalline compound which has only recently been identified chemically. It is necessary for growth, maintenance of appetite, and the prevention of a type of nerve disorder.

Chicks with diets inadequate in vitamin B_6 make slow growth, lose appetite, become emaciated, and develop muscular weakness. As the disease progresses they sit with their heads lying on the floor, and, before death, develop a trembling of legs and wings.

For growing chicks the minimum amount of this vitamin is 1,600 micrograms of pyridoxine per pound of feed. The optimum amount for safety is 1,900 micrograms per pound. The requirements for layers and breeders have not been determined.

Vitamin B_6 is comparatively stable and is widely distributed the same as vitamin B in both plant and animal products. It is found in liver, yeast, wheat by-products, rice by-products, grains and cane molasses. Like vitamin B, this vitamin is not likely to be lacking in practical diets.

VITAMIN D

Vitamin D, or the anti-rachitic factor, is of great importance to poultry as well as other livestock. Its discovery and the information about its use have revolutionized the poultry in-

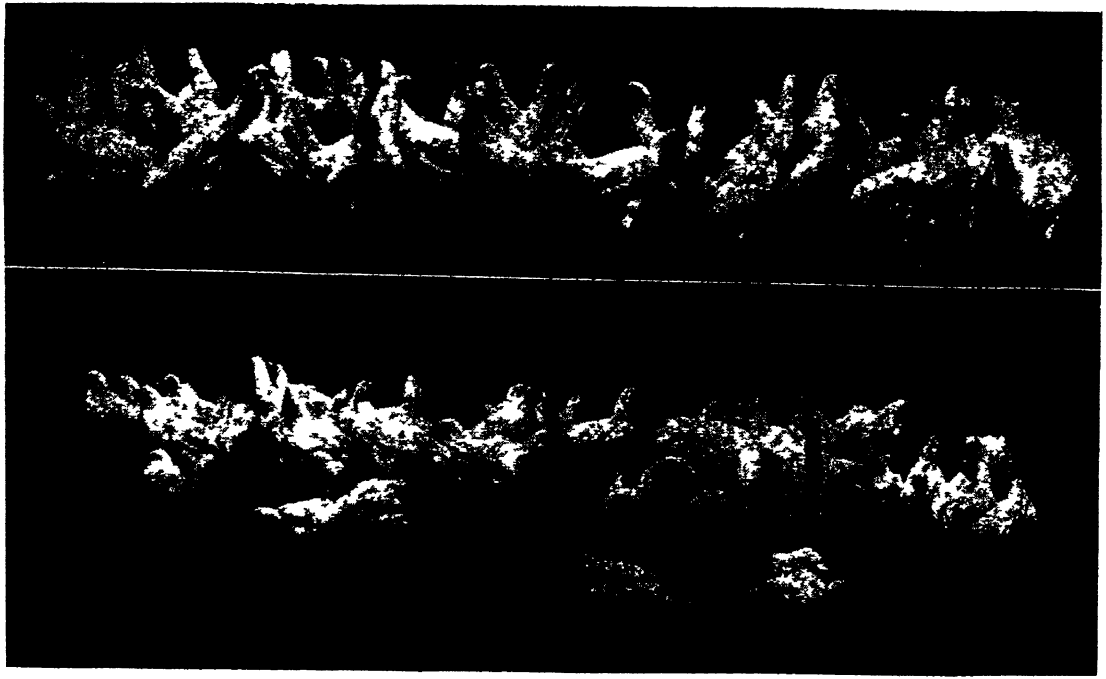


Fig. 90. Above, chickens eight weeks old, grown indoors but receiving cod-liver oil. Below, typical vitamin D deficiency. These chicks are the same age as those above, but have not had cod-liver oil in their ration, and were grown indoors. (Poultry Dept., Cornell University.)

dustry during the past twenty years. The use of this vitamin has made it possible to grow chickens indoors any month of the year under a variety of conditions.

Vitamin D aids in the proper assimilation and utilization of the calcium and phosphorus in the food supply, and indirectly affects growth. It also prevents rickets, the laying of thin-shelled eggs, and failure in egg production and hatchability. No trouble is likely to develop from a lack of this vitamin in the food supply as long as poultry receive sufficient exposure to direct sunlight. Under such conditions the short ultraviolet rays of the sun penetrate the exposed surface layers of the skin, particularly the legs and feet, causing synthesis of sufficient vitamin D to fulfill all requirements.

However, when poultry are confined and the sunlight to which they are exposed passes through common window glass, no benefit is derived since this kind of glass filters out the beneficial ultraviolet rays. Special glass or window coverings can be used which allow a portion of the ultraviolet rays to pass through, but such materials must be kept clean, as dirt prevents the passage of the rays. However, since the supply of vitamin D from sunlight is uncertain, owing to the variable number of cloudy days, especially in winter, which greatly reduce the amount of ultraviolet rays, the common practice of confining poultry, and the fact that ultraviolet rays in sunshine are one-eighth as effective in winter as in the summer months, it is generally considered safer to supply vitamin D in the ration.

When there is a deficiency of vitamin D, the bones of growing chickens do not harden properly (Fig. 90) and rickets or leg weakness results. At first the birds show lameness. Growth is slow. The first symptoms usually do not appear before the birds are a month old. As the disease progresses, the birds walk first in a stilted, stiff-legged manner, but later are unable to stand. The hock joints show enlargement. Finally death occurs. When autopsied, chickens show beading of the ribs

(Fig. 91), spinal curvature, and crooked breast bones. Similar conditions appear in hens. Positive diagnosis in chicks can be made by removing the tibia and splitting it. If rickets is

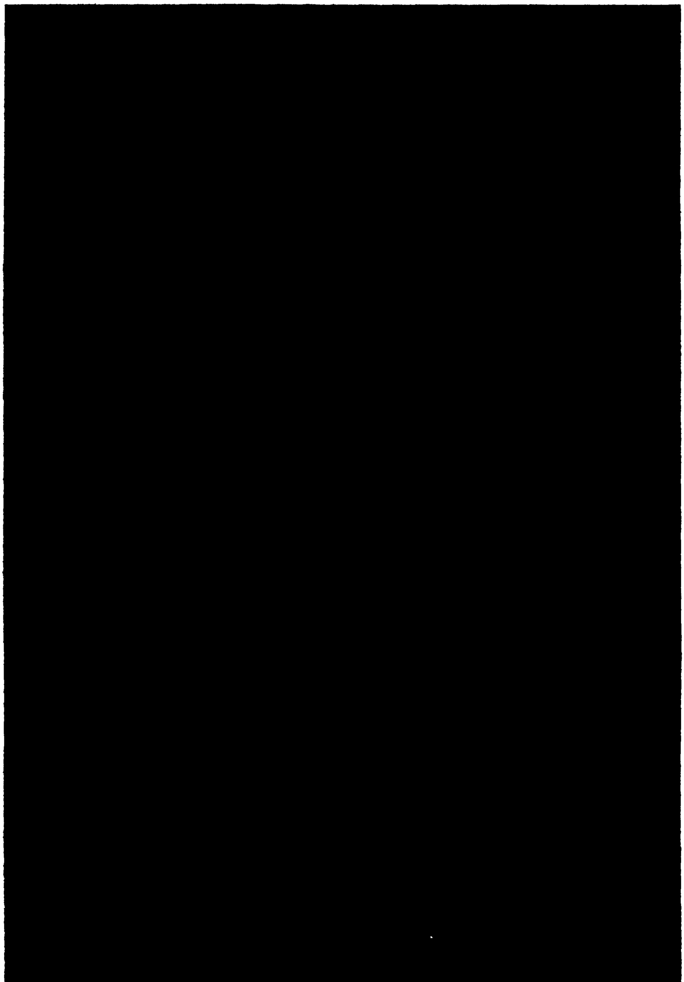


Fig. 91. Above, bony structure of cockerel showing normal condition of bones. Below, bad leg-weakness (vitamin D deficiency) at nine weeks. Note the extreme beading of the ribs (B), very crooked breastbone (A), and the thickening and softening of all bones.

present, the leg bone will be soft at the ball joint end (Fig. 92).

A good example of how a deficiency of vitamin D affects fowl follows. Most poultrymen of necessity keep their hens in-

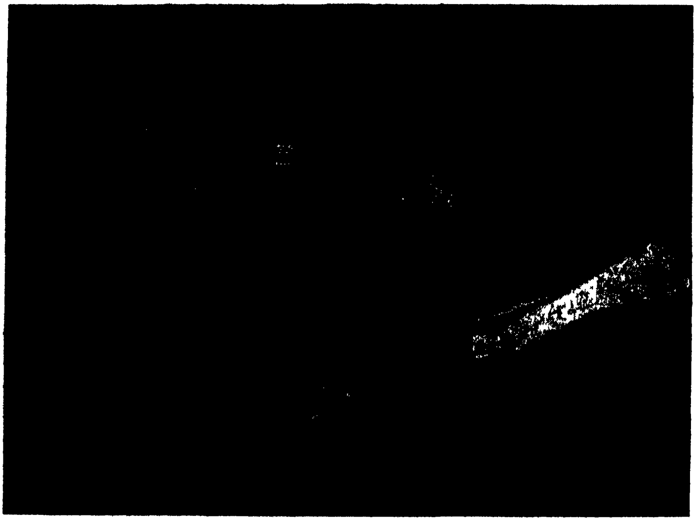


Fig. 92. Leg bones of a cockerel not showing leg-weakness (A) as compared with bad leg-weakness (B). Note the soft spongy hemorrhagic condition of the bone and the ball joint, broken off in removing the leg. (Courtesy of Poultry Dept., Cornell University.)

doors all winter away from much direct sunlight. If production has been particularly good when spring approaches, the hens may begin to lay a larger number of soft-shelled eggs than usual, and some of the birds may become temporarily lame. Examination of the eggs shows many with rough ends and thin spots. There is much egg-eating as a result of many thin-shelled eggs being broken in the nests. It is very probable that most of this trouble is due to lack of sufficient vitamin D or direct sunlight, for later when the hens run out-of-doors in the sunlight these difficulties cease.

The minimum requirement of vitamin D for chicks is 90 A. O. A. C. units per pound of feed. The optimum level for safety and storage for future use is 180 A. O. A. C. units per

pound. The minimum requirement for laying hens and breeders is much higher—270 A. O. A. C. units per pound of feed; and the optimum level for best production and hatchability is 450 A. O. A. C. units per pound.

The principal source of vitamin D, in addition to sunshine, is fish oils. However, vitamin-D properties may be conferred on certain animal and vegetable oils by irradiation with ultraviolet rays. Cholesterol is a sterol derived from the skin and tissues of animals, which, when activated, is known as 7 dehydrocholesterol. It is the predominant form of vitamin D in animal and fish oils. It is highly concentrated. Similarly, ergosterol is a sterol found in plants, particularly the fungi, ergot, and yeast. Concentrated products of irradiated ergosterol are known as viosterol and calciferol. They are not as effective for poultry as 7 dehydro-cholesterol.

Vitamin D is not easily destroyed by heat and exposure to the air. It may be stored in the body and in the egg.

VITAMIN E

Vitamin E, sometimes called the anti-sterility vitamin, is required for successful reproduction. It preserves the health of the reproductive organs and the brain. It prevents failure in hatchability, loss in fertility in males, and nutritional encephalomalacia (crazy-chick disease) in chicks.

Chicks suffering from a vitamin-E deficiency act crazy. They often fall forward or backward when they try to walk, and then wheel in circles. In extreme cases they suddenly become prostrated, with the legs extended and the head retracted. This is accompanied by tremors of both head and legs. Upon autopsy, lesions are found in the brain.

The requirements of vitamin E have not been determined. However, there is little danger of a deficiency of this vitamin, as it is widely distributed in poultry feeds. Vitamin E is found in cereals, certain vegetable oils, especially wheat-germ oil, wheat by-products, alfalfa, and leafy green feed. Vitamin E

is exceptionally stable except in the presence of rancidity or oxidative reactions in feeds. The possibility of such loss is reduced when freshly milled products move fairly rapidly to poultry farms. Rations containing large amounts of fat are undesirable for poultry for two reasons: first, because of the danger of rancidity; and second, because a large amount of fat may interfere with the availability of vitamin E.

VITAMIN G (RIBOFLAVIN)

Vitamin G is necessary for growth and hatchability. It preserves the health of the peripheral nerves and prevents nutritional leg paralysis (curly-toe disease, Fig. 93).

A deficiency of riboflavin in the egg results in early embryo mortality. Lack of this vitamin in the diet of growing chickens slows growth, increases the mortality and brings on a leg paralysis which causes the chicks to walk on their hocks with the toes turning inward. This usually takes place before the chicks are a month old.

Fig. 93. Leg paralysis caused by lack of vitamin G or riboflavin. Note the position of the hocks, with toes curled inward. (Courtesy of Poultry Dept., Cornell University.)

Less of this factor is required for layers than for breeding hens.

The minimum amount of this vitamin for growing chickens is 1,350 micrograms per pound of feed. The optimum level for best results is 1,600 micrograms per pound. The higher level is particularly important during the first month, when the chickens are most susceptible to curly-toe disease. Following the fifth week the requirement declines rapidly. Breeding hens require a minimum of 1,000 micrograms or an optimum of 1,200 per pound of feed. The optimum amount is advisable to assure proper storage of riboflavin in the eggs. Not only is the

hatch better, but the chicks have a carry-over which acts as a supplement to their ration early in life when they need it most.

The chief sources of riboflavin are milk products, yeast, liver meal, alfalfa meal, green feed, and by-products of the fermentation and distilling industries.

Vitamin G is a yellow crystalline compound. It is not rapidly destroyed by heat, and is quite stable under ordinary conditions of storage in feedstuffs.

A crooked-toe deformity resembling the curly toe caused by a deficiency of vitamin G has been shown by experiments at Cornell University to be due to the type of floor on which the chickens are kept. Chickens confined to paper-covered floors showed a much greater number of birds with deformities than those using wire-covered floors. It is thought that the hard slippery floor produced unusual strains on the legs of the birds, causing the deformities to develop. This condition is aggravated by crowding. In practice, coarse litter is suggested, and frequent cleaning to prevent impacted litter. This deformity should not be confused with true vitamin-G deficiency.

VITAMIN H (BIOTIN)

Vitamin H is a recent addition to the vitamin family. It is necessary for growth and prevents dermatosis similar to pantothenic-acid deficiency.

Biotin is known as the nutrient which prevents the so-called egg-white injury caused by feeding large quantities of egg white to rats. The uncooked egg white holds the biotin in the feed and it passes out undigested. The biotin-holding material avidin is destroyed by heat.

Reports from Pennsylvania State College indicate that dermatosis in turkey poults can be cleared up by feeding biotin.

The requirements for this vitamin have not been determined.

Vitamin H is found in grains, liver, yeast, cane molasses, alfalfa meal, and green grass.

VITAMIN K

Vitamin K, or the anti-hemorrhagic vitamin, is required by chickens to maintain normal clotting power of the blood. Without it they may bleed to death from the slightest injury. Fortunately this disease does not often occur in the field, as ordinary poultry rations are not likely to be deficient in this factor. Exact requirements have not been determined, although one per cent dehydrated alfalfa gives protection. Vitamin K is found in alfalfa meal, green grass, meat scrap, and fish meal. Dried cereal grasses are a rich source of this vitamin.

PANTOTHENIC ACID

Pantothenic acid is necessary for proper health of the skin and spinal cord. A lack of this vitamin in chicks results in scabby sores on the corners of the mouth, round the vent, and on the edges of the eyelids (Fig. 94). There is thickening of the skin on the bottoms of the feet and cracks appear. The feathers are ragged and may break at the base. Growth is slow and the birds have an awkward gait when they walk. This condition is known as dermatosis.

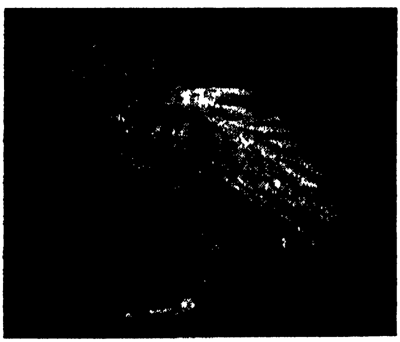


Fig. 94. Chick seven weeks old showing pellagra-like granulation of the eyelids and scabby incrustation of the corners of the mouth, and on the feet, caused by lack of pantothenic acid. (Courtesy of Poultry Dept., Cornell University.)

When pantothenic acid is deficient in the diet of adult birds, it results in poor hatchability and high embryonic mortality. There are no symptoms of dermatosis.

The minimum requirement of pantothenic acid for chicks is 2,700 micrograms per pound of feed. The optimum level is 3,200

micrograms. There is some evidence which points to a slightly lower requirement for heavy breeds. The requirement apparently for chicks under 8 weeks is higher than from that period to maturity. The requirement for adult birds has not been worked out.

Pantothenic acid is present in cane molasses, milk products, yeast, alfalfa meal, green grasses, and cereals. Average rations are not likely to be seriously deficient in this vitamin.

ANTI-GIZZARD EROSION FACTOR

A deficiency of this factor results in roughening or erosion of the lining of the gizzard leaving craterlike areas. This condition may occur in any part of the lining, but generally in the forward end. It is caused by hemorrhages between the lining and the gizzard tissue. In mild cases, brown stains appear in the gizzard lining. Advanced cases show clots of blood under the stained places, and in extreme cases holes appear in the lining, filled with particles of gizzard lining. Growth is not affected.

The requirements for this factor have not been determined as it has not been identified chemically. However, cholic acid of bile is reported to be an effective preventive of erosion.

Chief sources of this factor are alfalfa meal, green grasses, wheat by-products, oats and fresh milk. When some of these products are fed in adequate amounts in the ration there is usually little difficulty with gizzard lesions. It is particularly important to provide breeding hens with proper amounts of some of these feeds in advance of the breeding season, so that there is storage of this factor in the eggs, as this tends to reduce gizzard erosion early in the life of the chick when this condition is most serious.

It is well to keep in mind that finely ground feed that contains little or no grit may bring on an abnormal condition of the lining of the gizzard resembling gizzard erosion.

OTHER VITAMINS

Research in the vitamin field is constantly revealing new vitamins and new facts about the older ones. Among the newer vitamin factors not already described, is choline, which is necessary for egg production and bone development. Choline also prevents perosis in chickens and turkeys. It has been effective with turkeys in controlling perosis when manganese sulfate only partially controlled this condition.

Chief sources of choline are grains, wheat by-products, liver, meat scrap, and fish meal.

Factors R and S (Cornell) and factor U (California) are classified together as their functions have not yet been definitely differentiated. They are necessary for growth, reproduction and hatchability. They are reported to have a greater effect than riboflavin on the maintenance of body weight in hens and greater effect on egg production than hatchability. These factors are water soluble.

Glucuronic acid is also necessary for growth. Chondroitin which contains glucuronic acid aids in preventing gizzard erosion.

Chief sources of glucuronic acid are oats, wheat by-products, liver meal, meat scrap, and fish meal.

Information in regard to these vitamin factors is not complete.

Still other vitamin factors are reported which affect the nutrition of chicks. These include grass juice factor, cartilage growth factor, and folic acid.

XIII. Artificial Illumination as a Means of Increasing Egg Production

NO ONE factor in the management of a flock of laying hens is more effective in the control of egg production than the proper use of artificial illumination. It was first assumed that the increase in egg production resulting from the use of artificial light was due to the extra amount of feed which the birds consumed by lengthening the feeding day. *Recent experiments* indicate that the real reason for the increase in egg production is that light stimulates the pituitary gland at the base of the brain, causing it to produce a hormone in greater quantity which, in turn, stimulates the ovaries of the hen to extra activity. In other words, it is not increased feed consumption but the stimulation of light which gives results. Of course, with increased egg production more feed is required. The use of artificial illumination, however, is not in itself a guarantee that good egg production will follow. The number of hours of artificial light, the physical condition of the stock, the kind of ration, the house where the birds live, the climate, and the season of the year, are also factors that must be taken into consideration.

VALUE OF ARTIFICIAL ILLUMINATION

Experiments at Cornell University and other experiment stations show that while the annual egg production of a flock may be increased slightly by artificial illumination, the greatest benefit comes by a more even distribution of the eggs through the year and the production of more eggs during the fall and winter when prices are highest. This generally increases the total value of the eggs for the year.

Exhaustive tests have been made by the Poultry Depart-

ment at Cornell University and other experiment stations to determine the best time of day to use artificial illumination. These tests show that good results were obtained by any of the following methods: (1) Evening light only for three or four hours beginning at dusk; (2) evening lunch, between eight and nine at night; (3) morning light only for three or four hours until daylight; (4) two or three hours of illumination on both ends of the day; and (5) all night lights.

The operator, therefore, may use lights at any time of the

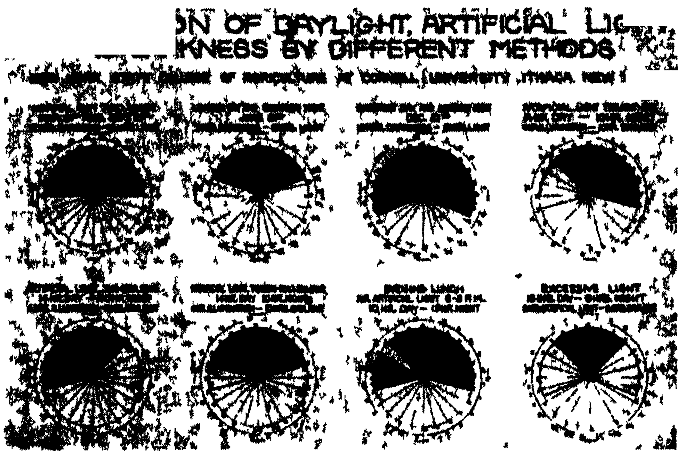


Fig 95 Distribution of light during a day. It is not advisable to give hens more than a fourteen hour day

day that is most convenient, and, according to his judgment, adds most to the comfort of the birds.

Early evening illumination usually furnishes the extra light on the warmest end of a winter day, which makes it pleasanter both for the hens and the feeder. With lanterns it may be more convenient to use light while doing the evening chores than early in the morning. On the other hand, evening lights require closer attention or more expensive equipment, for the operator must either be on hand to dim and turn off the lights or provide an automatic arrangement to do it for him.

When illumination is used for one hour between eight and nine in the evening, less light is required.

Morning illumination usually comes at the coldest time of the day and is unhandy for the operator unless an automatic device can turn on the lights, and water is supplied in non-freezing fountains. When the above objections are overcome, this makes one of the most natural ways of using illumination, for the hens being hungry after a long night's rest readily come down off the perches and begin to exercise. It is not necessary to dim morning lights.

Results from all-night lighting are about the same as for the other methods of supplying artificial light. Ten or fifteen watt lamps or just enough light is provided over the feeders and drinking pans so that the birds can see to go back and forth to eat and drink at any hour of the night. The principal difference, if any, between this and other methods of supplying light is probably in the amount of power or fuel used. No time switch is needed with all-night lighting.

When artificial illumination is used for an hour or two both in the morning and the evening, it has one advantage over any other method except all night lighting, of providing a perfectly uniform day and night, thus overcoming the constantly changing sunrise and sunset which is going on throughout the entire season. This is important, as even a small difference in the length of day is likely to affect production.

In the latitude of New York an eleven-hour night and a thirteen-hour day makes the most desirable lighting plan. The length of the day will depend to a large extent on the breeding and physical condition of the stock; well-bred birds require less light than poorly bred ones. Stock out of condition must not be given artificial light until they are physically fit to stand the strain of egg production. In any case, it is unwise to give hens more than a fourteen-hour day unless all night light is used, as egg production is not likely to be improved and the cost of lighting is increased.

Usually the time to begin lights is when the nights become longer than the days. This of course will vary according to the latitude. Then also, maturity, laying and physical condition of the birds will have to be considered. Thus, it is difficult to state just when artificial illumination should be started on every flock. Generally with pullets it is a good plan to try to get the desired production without lights, but if this is unsuccessful lights can then be started. It usually takes about 21 days after light is started to show the full effect of its use.

It is best to begin lights gradually and increase the period of light as the season advances. If morning and evening light is used, illumination should be turned on at both ends of the day at the same time. Light can be turned on abruptly without any disastrous results but it is usually easier to control the egg production and the body weight of the birds if it is done slowly.

Tests have shown that hens are very sensitive to a change in the length of day. If the feeding day is shorter by only fifteen minutes, it is soon noticed in the production. Likewise, when artificial light is suddenly discontinued, perhaps by accident or otherwise, for less than a week, the egg production is likely to be affected. Once artificial light is in operation in the fall, it is disastrous to discontinue it for any reason until the following spring. In case something does happen, when electricity is used for illumination, so that power is not available, gasoline lanterns should be used until conditions are normal again. This may be the means of saving many dollars in lost egg production.

As a rule it is not advisable to force hens under artificial illumination beyond a 60- to 70-per-cent production. The reason for this is that it is more difficult in cold weather to keep laying hens in good flesh than it is in summer. The feeder, therefore, who forces his hens to lay as high as 70 or 80 per cent or better, runs a good chance of a serious slump in egg production, followed by a molt at a time when, if disease is present, the birds are least able to resist it.

Illumination should be continued in the spring until the length of the natural day reaches twelve or thirteen hours, or is equal to the length of day provided by artificial means. In the latitude of New York state this will be about April 1st. The sudden stopping of illumination at too early a period is one of the commonest causes of putting birds out of condition and throwing them into a spring molt.

METHOD OF FEEDING AND MANAGEMENT UNDER ILLUMINATION

When artificial illumination is employed, the feed mixtures remain unchanged but the method of feeding must be adapted to the type of illumination. If morning illumination is used, the grain may be scattered in the litter the night before. Dry mash and water should be available during the entire time that the birds are off the roost. Grain should be fed heavily at the end of the day, about one and a half hours before the birds go to roost. During very cold weather it may be advisable in order to keep the birds active, to give a very small feeding of grain at noon. Of course, if the free-choice or the all-mash methods of feeding are followed, feed will always be available. Most important of all, it is necessary by weighing regularly a few marked birds to watch the flesh condition. They should not be allowed to get thin.

Pullets will always do better under illumination when they are separated into flocks of the same maturity and condition. Consequently, the first step is to put all the early-maturing birds of the same age in a pen by themselves. These birds generally make the best layers and due to their better breeding will need less light. The slower maturing birds, not having the tendency to lay as well, should be given a maximum light day in an endeavor to overcome the handicap of breeding by light stimulation.

Although the use of artificial illumination will bring immature pullets into laying condition at an earlier age, it is usually

not advisable. It is better not to use lights and have such birds develop naturally and more slowly and be more completely mature in body when laying starts. When they begin to lay too early in life their eggs are much smaller and it takes a longer period of laying before they reach maximum size. Furthermore, when pullets are not well developed in body it is more difficult to keep them laying, as they must complete their growth and lay at the same time.

The hens, like the pullets, will do best under artificial illumination when they are separated into flocks according to the time they stop laying in the summer and fall. The birds that stop laying in June, July, and early August are usually not good enough layers to make it worth while to bother with them. They should be sold.

Those that stop laying during late August and September generally are the better class of hens. It will pay to keep them and put them under lights early in November. It is necessary, however, to allow such hens about eight weeks in which to recover their plumage and regain their weight before they start on another year's production. Failure to give hens this rest period often results in very unsatisfactory production during the rest of the winter season. Apparently, hens need a short period of rest and an opportunity to regain their vigor between laying years.

Hens that stop during October and early November should be handled in exactly the same way as the August and September molters, *i.e.*, they should have a rest period of eight weeks before being forced into production again. In the latitude of New York, it is not considered good practice to allow hens to lay later in the fall than November, even if they have the inclination to lay later, because when they molt in the winter they suffer from the cold. Sometimes it is difficult to stop the better layers.

However, the egg production of these persistent layers can usually be checked by making changes in the feed and manage-

ment, by withholding the water for a day, if necessary, and discontinuing the lights. (See Chapter XI, page 236.)

About a month before eggs are saved for hatching, the regular amount of artificial illumination (thirteen-hour day, eleven-hour night) should be given the breeders. This will bring them into full lay at the time eggs are needed for incubation. Experiments conducted by the Poultry Department of Cornell University show that the best fertility and hatches occur when birds are on the increase in production, or are maintaining a high production.

On some farms an hour or two of artificial illumination is used on the hens beginning early in the fall or about the first week in September to prolong production. This is effective in stimulating and sustaining production until the pullets are in full lay. The lights in this case are discontinued early in November, so that the birds can have their rest period before cold weather sets in.

In some parts of the United States poultrymen force their hens to molt during June and July, and bring them back into production with artificial illumination in September. This practice assures good production of large eggs when prices are highest. The birds are thrown out of production by the methods described above.

COST AND SOURCES OR ARTIFICIAL ILLUMINATION

The cost of fuel or power to furnish light for a flock of hens is small. At the New Jersey Agricultural Experiment Station, the fuel and operating cost of providing artificial illumination for 1,100 birds, the current being supplied by a Western Electric Farm Lighting Unit, was .044 cents for each bird for the season. At this rate one extra egg from each hen will almost pay for the cost of the power. Frequently poultrymen with large flocks have been able to pay for the installation of a private lighting plant in one season, from the increased returns from their hens.

Fig. 96. Types of gasoline lanterns with shades, used in lighting poultry-houses.

Electric lights, gasoline and kerosene lanterns, and acetylene gas, represent the different kinds of light employed in lighting poultry-houses. Gasoline and kerosene lanterns can be used where electric power is not available or when the size of the poultry enterprise will not justify more ex-

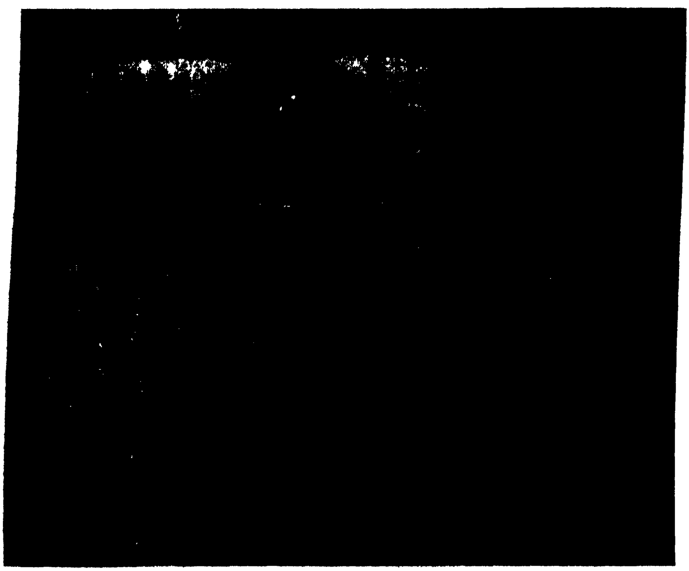


Fig. 97. Proper placing of the lamp, 6 feet from the floor and 10 feet apart, with shades so that there is an even distribution of light on the floor for the birds when eating. A cone shaped reflector 16 inches in diameter at the base by 4 inches high will add 50 per cent to the intensity of light on the floor, if painted with aluminum on the inside. (Cornell University)

pensive equipment. Reflectors are needed with this type of illumination.

Electric light (Fig. 97) is the most desirable as it is more convenient, requires little labor, is fairly economical and is less likely to cause fire. The cost of installing electricity, especially when a private lighting system is necessary, is the principal disadvantage. Some automatic device is often used for turning on and off the lights. A homemade device attached to an alarm clock may be used for this purpose.

XIV. Marketing Eggs

PROBABLY no animal product of the farm is produced in a more sanitary or convenient form for marketing than eggs. They are one of nature's choicest food products. Nevertheless, many farmers experience considerable difficulty in shipping eggs to market that will command the top price. The principal reason is probably due to the fact that eggs are very perishable when improperly handled and are then very quickly affected by their surroundings.

The sale of eggs is also governed by their interior quality, size, color, appearance, the type and condition of container, season of the year, and the like. All these factors may be controlled to a large extent by breeding, proper care, and good management.

The freshness of an egg has to do with its age and quality, when used for food. The highest standard of quality in an egg is one just laid ("new laid"). It is customary to speak of "new laid" eggs as fresh eggs. Almost every one has this definition in mind when speaking of fresh eggs; but, inasmuch as the quality of an egg is very quickly affected by unfavorable surroundings, freshness is more largely a matter of care and handling after the egg is laid rather than age. For example, it is possible seriously to impair the quality of "new laid" eggs in two or three days, while on the other hand the same eggs, under favorable conditions, might remain fairly fresh after several weeks in storage. This results in several grades of eggs according to their interior quality regardless of age.

STRUCTURE OF EGGS[1]

"To understand what takes place in eggs when they deteriorate in quality and the factors that are considered in the

[1] Rob R. Slocum, U. S. D. A. Bul. 583, p. 20.

pricing and utilization of eggs, it is desirable to have some knowledge of their structure and of the relationship of one part to another" (Fig. 47).

"In a normal new-laid egg of good quality, the yolk is nearly spherical and of a uniform surface color. On the surface of the yolk, usually the upper side when the egg is broken out, there is a small area lighter in color and about 1/8 inch in diameter known as the germ spot. It is in this spot that embryo development in a fertile egg begins; consequently the size and appearance of the germ spot on the yolk, when viewed before the candle, is of importance in determining the grade. The yolk material is enclosed in a covering called the vitelline membrane, which holds the yolk in its normal shape. However, as an egg ages, the yolk tends to take up water from the white with a consequent enlargement in size, and the yolk membrane weakens as a result, permitting the yolk to assume a more flattened or spread-out shape when the egg is broken out on a flat surface."

"The white, or albumen, of the egg consists of several parts or layers of thick and thin white (see Fig. 47). The yolk is suspended in the white by a twisted, ropelike mass at each end of the egg, known as the chalaza. The yolk floats and turns easily within the white."

"Lining the shell are two membranes commonly described as the inner shell membrane, which is next to the contents of the egg, and the outer shell membrane, which is next to the shell. These membranes are close together and normally do not become separated except at the large end where, as the fresh egg cools and as it ages and the water and gas escape from the egg, the two membranes draw apart and the space between them is filled with air."

"The shell is the container for the liquid parts within. When new-laid the egg is coated with a gelatinous covering which tends to seal the pores and gives the shell its bloom."

"Unless eggs are handled and kept under good conditions,

in a relatively short time they may reach a stage at which they are no longer edible. One of the first indications of deterioration is the evaporation of water from the white through the shell, with the consequent enlargement of the air cell. Another is the flattening of the yolk already described."

ENVIRONMENTAL FACTORS THAT AFFECT THE INTERIOR QUALITY OF EGGS

Familiarity with the factors that affect the quality of eggs is essential, if they are to be handled with proper care.

Temperature. It is very important that eggs should be removed immediately after they are laid and placed in a clean cellar or room that has a uniform temperature between 50° and 60° F., the nearer 50° the better. Every hour that eggs are held at temperatures above 60°, deterioration results, regardless of whether they are fertile or infertile.

For this reason it is very important in hot weather to gather the eggs at least three times a day, and four is better.

Sharp and Powell at Cornell University were among the first to point out the effect of temperature on the rate of deterioration. Their findings show that fertile new-laid eggs drop to the quality of U. S. Standards (Grade B) in three days at a temperature of 98.6° F.; eight days are required at 77° F.; twenty-three days at 60.8° F.; sixty-five days at 44.6° F. and one hundred days at 37.6° F.

With continued high temperatures the mucin fibers in the albumen of the egg break down and become watery. Water passes from the albumen to the yolk which increases its weight and causes the yolk to flatten. Carbon dioxide, a beneficial gas, is driven out of the egg. On the other hand, rapid cooling delays the break down of the albumen, and slows up the loss of carbon dioxide.

High temperatures are especially harmful to fertile eggs. In such eggs the embryo starts developing during the last few hours before the egg is laid, and, unless the egg is cooled to

below 68° immediately after it is laid, growth will continue. Lack of proper incubating temperature will result in the death of the embryo and the egg will soon become rotten and unfit for food.

During hot weather or when hens are laying heavily, or broody hens are not removed, the eggs may continue at or near incubation temperature in the nests for several hours after they are laid, unless they are gathered frequently. In such instances the embryo may be well enough advanced to be seen when candled. The production of fertile eggs should be avoided except for incubation purposes.

The males have no influence on the number of eggs the hens lay. They are necessary only when fertile eggs are desired for incubation purposes.

Humidity. Eggs maintain their quality best in an atmosphere where the relative humidity is 70 per cent or above. Inasmuch as the shell of an egg is very porous, warm dry air surrounding it causes rapid evaporation especially if it blows over the egg. Weak watery albumen and stale flavor results. Evaporation increases the size of the air cell and lowers the grade of an egg when candled. Low humidity frequently produces a pronounced mottled appearance of the shell and a ring around the edge of the air cell. Moderate ventilation is best in maintaining high humidity and low temperature in an egg room.

The humidity of the holding room can be determined by means of a hygrometer or sling psychrometer.

High humidity can be obtained in the holding room in several ways: the floor may be kept wet by means of wooden frames 5 inches deep containing wet sand around the sides of the room; a fine spray of water may be thrown off in the air or against burlap; or an electric fan can be arranged to force air through a wet burlap or excelsior pad into a storage cabinet where wire baskets with eggs are placed. This latter method has been particularly helpful in maintaining quality in eggs.

ALBUMEN CONDITION

The albumen condition of eggs may vary widely when they are first laid. This ability of hens to produce eggs of thick or

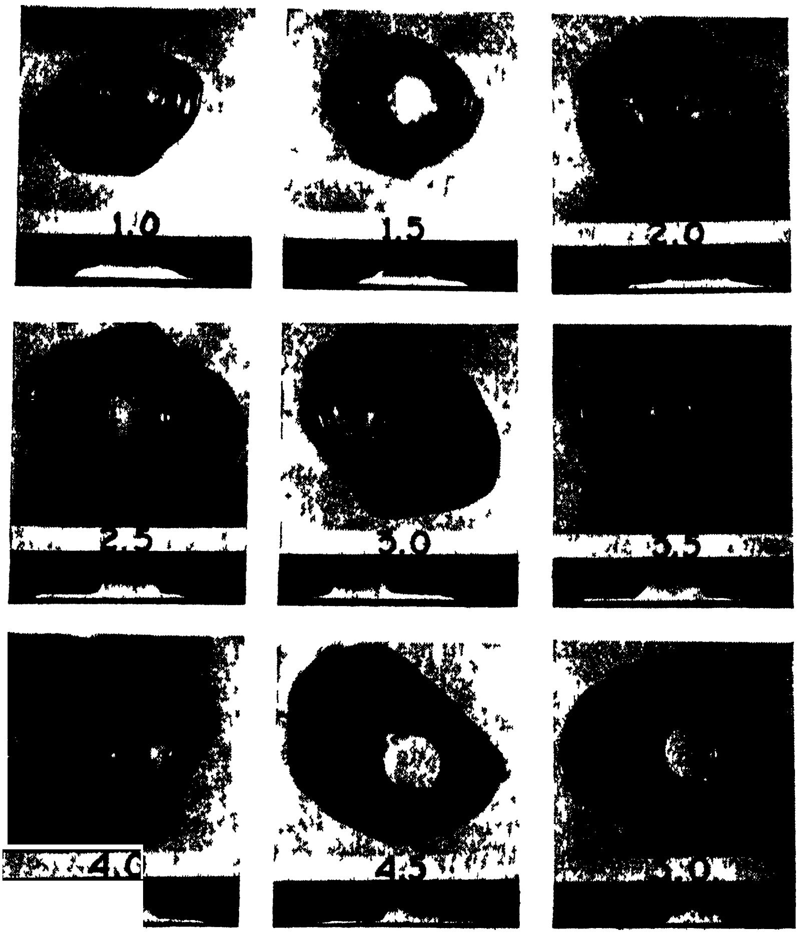


Fig. 98. The variation in quality of new-laid eggs. The above eggs, each broken on the day it was laid, are arranged in a series to show the variation in the firmness of the albumen. Egg 1.0 has a firm thick white which supports the yolk, and egg 5.0 a very watery white. The height of the albumen can best be seen in the side view just beneath each top view. (Courtesy of A. Van Wagenen, Cornell University)

thin albumen is inherited and transmitted to their progeny. Since albumen quality is a matter of breeding, poultry breeders are able to test their breeding hens and make matings to improve egg quality. Fig. 98 shows the variation in quality of new-laid eggs.

Recent investigations reveal that the difference in albumen condition are associated with the presence and size of cells secreting mucin in the oviduct. Fowls producing eggs of high-quality albumen possess a consistently better cell in the albumen secreting region than those producing a more watery albumen. This fact makes it possible to distinguish between the birds that produce high and low quality eggs. It can be done in this way:

The hens that lay eggs of comparatively good quality albumen do so throughout the entire laying year and even longer, while the other hens after laying satisfactory eggs for three or four months begin to lay eggs of decidedly poorer quality. By breaking a few eggs from each hen toward the close of their laying year and examining them carefully, the quality of each hen's eggs can then be determined. Hens producing eggs of the poorest quality can then be culled out of the breeding pens.

Changes in the albumen condition take place in every bird with age and the season of the year. As pullets grow older, the condition of the albumen becomes poorer, but these changes occur relatively rapidly or slowly, depending on the individual. The albumen condition of eggs from the entire flock are usually poorer during the summer season.

FEEDING

Up to the present time, experimental results show that with the exception of the shell and yolk, egg quality is not affected very much by feeding. Of course, the amount of vitamins A, B_1, G and D in the egg may be increased by feeding diets that contain relatively large quantities of these vitamins.

A lack of vitamin D or lime (calcium carbonate), or both, in the ration is likely to result in the hens producing eggs with thin shells, which are easily broken. The California Agricultural Experiment Station has reported that eggshell thickness is also inherited and may be influenced by breeding. Directions for supplying vitamin D and calcium carbonate are given in Chapter X.

The yolk color of an egg is determined by the amount of xanthophyll (yellow color) in the feeds which the hen receives. Birds that run on pasture or receive rations containing large amounts of dried alfalfa or yellow corn, produce eggs with darker yellow color. Fresh green leaves of plants of any kind carry large amounts of xanthophyll. Pimento peppers produce dark reddish brown yolks when fed to laying hens. Manufacturers of noodles and mayonnaise use such yolks to increase the yellow color of mixed yolks.

"It is best not to permit laying chickens to eat certain feedstuffs and plants. For example: if there is more than 5 per cent of cottonseed meal in the diet, the yolks tend to become mottled if the eggs are stored for several months; also the whites may acquire a pink tinge. Certain plants, such as cheese weed, have a similar effect on the white. Shepherds-purse and field pennycress have been reported to produce a green color in both the white and the yolk. Many strongly flavored feedstuffs, such as turnips, onions, garlic and leeks, sometimes produce undesirable flavors in eggs, especially if large quantities are consumed. Certain fish oils have also been found to produce a fishy flavor, but codliver oil or sardine oil of good quality ordinarily have no undesirable effect on the flavor of eggs, if fed at the proper levels."[2]

"DARK YOLKS"

Serious cuts in price and grade are made in most markets for eggs showing "dark yolks" before the candle. This ap-

[2] Harry W. Titus, U. S. D. A. Bul. 583, p. 81.

pearance of the egg may be due to two things. First, in an egg of good albumen condition, but deep yellow yolk color, the yolk may show enough shadow before the candle to give it the appearance of an egg of lower quality. The second group of eggs comprises those that have considerable thin albumen, due perhaps to poor care. The yolks in these eggs may be of average color, but appear dark when candled because the thin white permits the yolk to float near the shell, causing the dark shadow. Many market men do not distinguish between these two kinds of eggs and consider that feeding is the cause of all "dark yolks." In most cases, it is likely to be poor albumen condition, as it is difficult to see any difference in yolk color in good-quality eggs unless the yolks are very dark in color.

Consumers vary in their choice of yolk color. The best trade prefers eggs of moderate but uniform color. Deep orange or very pale yellow yolks are less favored. Eggs with dark yellow yolks, and whites of a greenish cast, are more likely to have a better supply of vitamins.

ODORS AND FLAVORS

Eggs are likely to take odors and flavors readily, therefore care should be taken to keep them away from filth, disinfectants, decayed vegetables, foul water or any other material that might taint them. It is important to use clean new cartons, or flats and fillers, when shipping eggs, so that mustiness and other odors from soiled containers will not be absorbed. (See Chapter X, page 214.)

According to the Massachusetts Agricultural Experiment Station, some hens may produce eggs with a "fishy" flavor. This characteristic is inherited. The hens having this character may be detected by trapnesting the flock and examining the eggs of each bird.

ROUGH HANDLING

Rough or excessive handling of eggs, even if the shells are not cracked or broken, causes depreciation in quality by less-

ening the firmness of the yolk and white and by breaking or loosening the air-cell.

ABNORMAL EGGS

The fact that an egg has just been laid is no guarantee that it possesses the highest degree of quality. In nearly every flock there may be one or more birds that produce defective eggs that have to be discarded.

Eggs with blood clots, bloody eggs, and meat spots are examples. A blood clot is caused by the rupture of a small blood vessel in the ovary or oviduct while the egg is being formed. Most clots appear on the yolk, which indicates that the hemorrhage occurred in the follicle at the time of ovulation. If the clot appears in the white and spreads through the albumen giving it a pink or red cast, it is known as a bloody egg. Bloody eggs are usually the result of more severe hemorrhages, probably in the wall of the oviduct. The oviduct of a hen is easily ruptured when she is in production. Fright, jumping down from high roosts or nests, a deficiency of vitamin D due to close confinement, a deficiency of vitamin K and poor physical condition may cause blood spots. An egg with a small blood clot may be used at home after the clot is removed, but should not be marketed. The customer may not understand what causes such clots. Furthermore, the sight of the blood may be repulsive and discourage the use of eggs.

Meat spots consist of small pieces of tissue from the ovary or oviduct which are torn away or become dislodged when an egg is formed. They are brown or opaque in appearance. A small meat spot does not render an egg inedible but large ones are objectionable.

Other abnormal eggs appear in any large flock more or less frequently. Double-yolked eggs are the most common. They result when two yolks develop at the same time and rupture simultaneously into the oviduct where they are inclosed in the same albumen, membranes and shell.

Pullets are more likely to produce double-yolked eggs than hens. Apparently it takes a little time for the ovary of a high producing bird to become adjusted to normal production. Double-yolked eggs may be fertile. Chicks are rarely hatched from them.

Soft-shelled eggs are caused when the shell glands fail to secrete, or they may result when the peristaltic constrictions in the oviduct become so violent that the egg is pushed along so fast there is not sufficient time for the secretion and formation of the shell. Lack of calcium carbonate in the diet or vitamin D are important contributing factors. (See Chapter X, page 211.)

Small yolkless eggs are of common occurrence and may be caused by the stimulus produced by some foreign material, such as a piece of membrane or similar material, gaining entrance to the oviduct and continuing through the oviduct in the same way as the yolk.

Occasionally an egg is found within an egg. Due to fright or some violent change, a completely formed egg may be forced back to the upper part of the oviduct by the muscles of the oviduct. When it again passes through the oviduct, albumen, membranes and another shell is formed. Strong reverse peristaltic action often forces the egg out of the funnel of the oviduct into the body cavity.

Hens that have an accumulation of eggs in the body cavity are called "internal layers." This sometimes causes them to walk like a penguin and will finally result in death. If one of these body-held eggs is laid, it is inedible.

Hens that regularly lay abnormal eggs can be detected by trapnesting and then culled out.

EFFECT OF DIRT AND WASHING ON INTERIOR QUALITY

When wet manure or dirt come in contact with the shell of an egg destructive bacteria, if present, pass through the pores of the shell into the egg. Washing will remove the dirt from the outside, but not the bacteria from inside the shell.

Furthermore, washing spreads the bacteria over the shell and increases the chances of shell invasion.

When stored, a larger number of dirty eggs have bacteria within them than clean eggs. Also, a larger number of washed dirty eggs show bacteria than dirty unwashed eggs. The loss from dirty eggs is considerable. Consequently, every effort should be made to produce clean eggs. Not only will the quality be better preserved, but much labor will be eliminated in packing eggs for market.

The Missouri Agricultural Experiment Station reports that soiled eggs cleaned with a one per cent lye solution kept as well in storage as clean eggs. Rubber gloves should be used when cleaning eggs in this solution. If the eggs are lowered into the solution in wire baskets and stirred after a few minutes, the eggs that are not too badly stained will be cleaned without further handling. The solution should be changed frequently, so that it will destroy bacteria effectively in the dirt on the shell. The temperature of the solution should be much higher than the eggs to prevent its being absorbed by the eggs.

METHODS OF MEASURING INTERIOR QUALITY

In recent years several methods of measuring the interior quality of eggs, after they are broken out, have been developed. None of these have much value commercially, but they have had an important influence in determining the effect of different factors on the interior quality of eggs. One such method developed by A. Van Wagenen at Cornell University is shown in Fig. 98.

HOW TO DETERMINE THE INTERIOR QUALITY OF EGGS BY CANDLING

The best method of determining the interior quality of an egg without breaking it is by candling. The candling of an egg means the process by which the contents is made visible by

rotating it before a strong light. By this process a person accustomed to candling can eliminate eggs of undesirable character and can detect nearly every fault with remarkable accuracy.

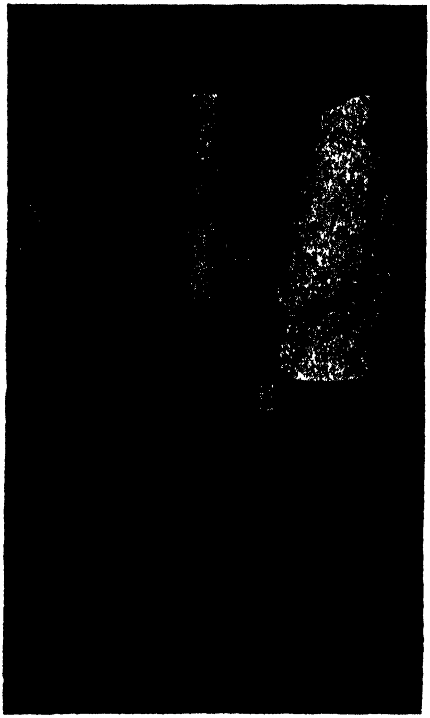


Fig. 99. A home-made candling device that can be lighted by electricity or by an oil lamp. This type of candler is used in a dark room.

Many inexpensive devices can be used for candling eggs (Fig. 99). A good tester is made from a piece of six-inch stove pipe, or a wooden box 8 inches square and 18 inches high, with a hole about 1¼ inches in diameter opposite the light. A 40-watt electric lamp is advisable in such a device, but an oil lamp can be used. A piece of tin or a polished reflector directly behind the light gives a greater brilliancy. When an oil lamp is used, a number of small holes should be cut around the bottom for ventilation. This type of candler must be employed in a darkened room. Especially constructed candling devices may also be purchased.

The daylight candler is arranged so that candling can be done in a lighted room and is more pleasant for the operator. If a strong light is used, more accurate and rapid work can be done especially when brown-shelled eggs are examined. A table or bench under the candling equipment is necessary for quick and easy candling.

When candling, the egg should be held about one foot in front and below the level of the eye. This takes the glare of the light away and permits the air-cell as well as the yolk to be seen. The egg should be held with the large end up as the air space will normally be at the upper end. Just as the

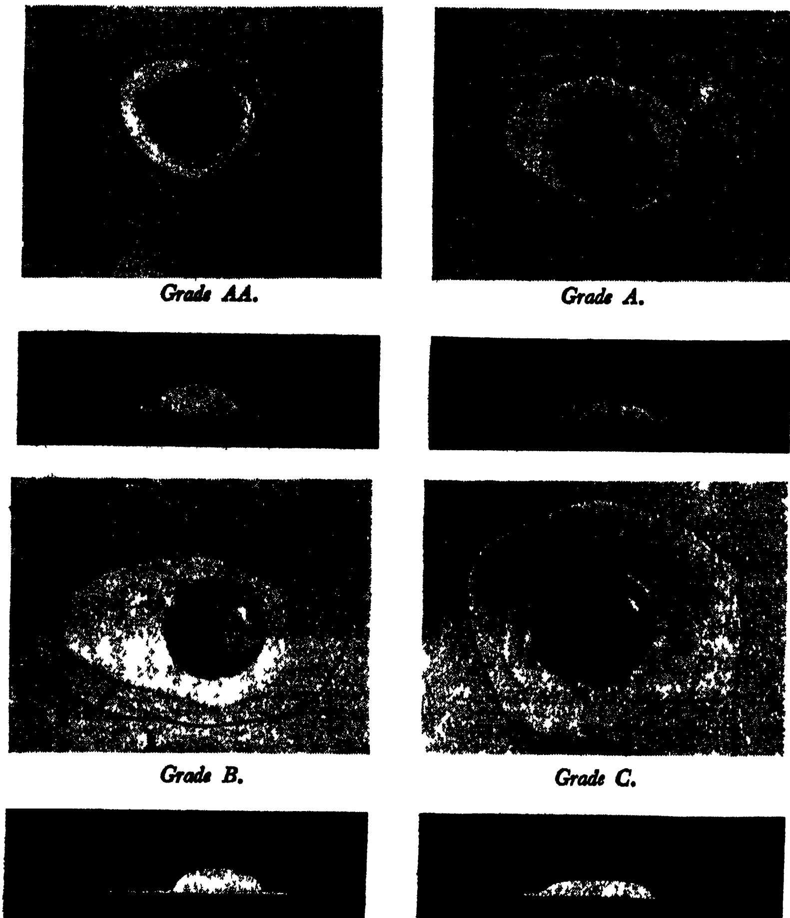


Fig. 100. The interior quality of broken-out eggs of the four U. S. grades, Specials (Fancy, or AA), Extras (A), Standards (B), and Trades (C), using the VanWagenen method of comparison. Note the difference in the consistency of the white and the flatness of the yolk between grade AA and grade C. (Courtesy of A. Van Wagenen, Cornell Univ.)

egg is placed before the light, it is given a twirl by a quick twist of the wrist so that a better view of the interior may be seen.

EXTERIOR QUALITY OF EGGS

The outside appearance of eggs is judged by their size, shape, color, uniformity, and quality of shell (Table XXX).

TABLE XXX

U. S. STANDARDS OF QUALITY FOR INDIVIDUAL EGGS

(Drawn up and established by U. S. Department of Agriculture, Bureau of Agricultural Economics)

Quality Factors	Specifications of Each Quality Factor			
	U. S. Special (AA)	U. S. Extra (A)	U. S. Standard (B)	U. S. Trade (C)
Shell....	Clean; sound; normal.	Clean; sound; normal.	Clean; sound; may be slightly abnormal.	Clean; sound; may be abnormal.
Air cell..	One-eighth inch or less in depth; regular.	Two-eighths inch or less in depth; regular.*	Three-eighths inch or less in depth; may show movement not in excess of one-half inch.	May be over three-eighths inch in depth; may show movement in excess of one-half inch; may be bubbly or free.
Yolk....	Well centered; outline indistinct; motion sluggish; free from visible germ development and other defects or blemishes.	Fairly well centered; outline moderately defined; may be slightly mobile; free from visible germ development and practically free from other defects or blemishes.	Outline well defined; may be mobile; may show slightly visible germ development and other definite but not serious defects.	May be plainly visible; may be freely mobile and cast dark shadow; and show clearly visible germ development but no blood; may show other serious defects.
White...	Firm; clear.	Firm; clear.	Reasonably firm; clear.	May be weak and watery.

* Eggs that otherwise fully meet the specifications of U. S. Extra but have slightly tremulous air cell (a movement not in excess of one-eighth inch) may be classed as U. S. Extras in the retail grade of U. S. Extras.

The results of experimental work by Benjamin at Cornell University show that the characters of size, shape and color of the shell are inherited and that by carefully selecting the proper type of eggs for hatching each year, a marked improvement will result in a short time.

The size of eggs is determined by appearance and weight (Fig. 101). Size ranks next to interior quality in determining the price, for large eggs are more attractive to the buyer. Market eggs range in size from $1\frac{1}{4}$ to $2\frac{1}{2}$ ounces or more each. Eggs smaller or larger are not marketable and are usually consumed at home.

Fancy eggs should weigh from $2\frac{1}{4}$ to $2\frac{1}{2}$ ounces or more each, 27 ounces to the dozen, or $50\frac{1}{2}$ pounds net[8] to the thirty-

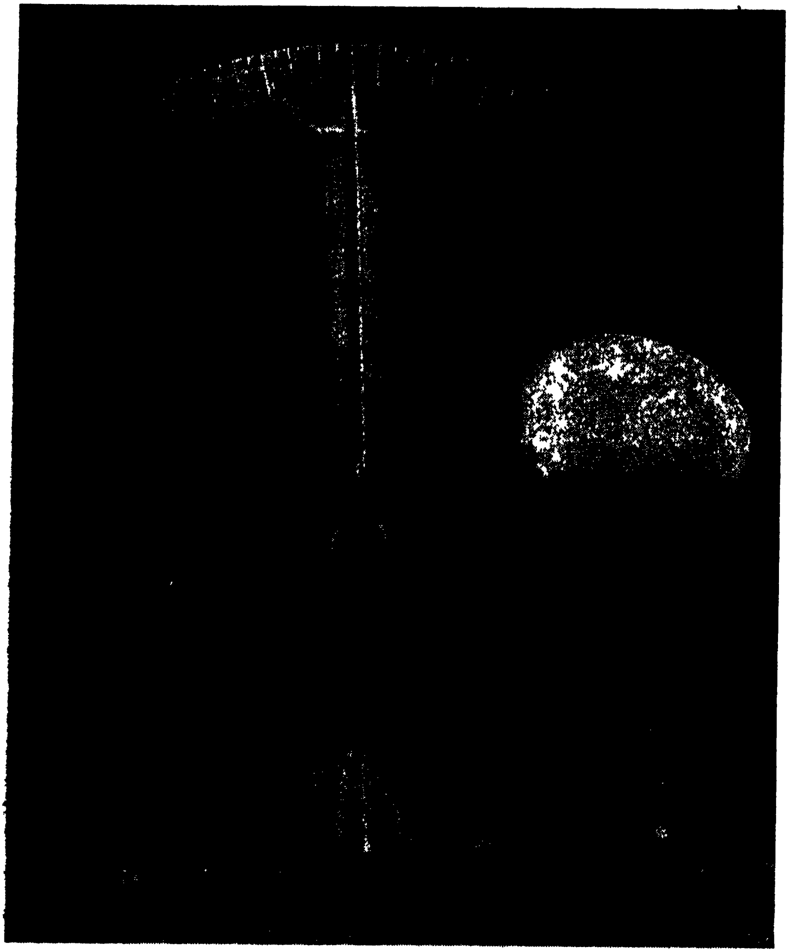


Fig. 101. Scales for weighing individual eggs.

dozen case. Only a small fraction of the eggs produced on most farms will go in this grade.

[8] Add 12 pounds to the net weight to get the gross weight when flats, fillers and excelsior pads are used.

The standard size of first-quality eggs in nearly every market in the United States varies between 1$\frac{15}{16}$ to 2$\frac{1}{4}$ ounces for each egg, 24 ounces to the dozen, or 45 pounds net to the thirty-dozen case.

Medium-sized eggs range between 1$\frac{5}{8}$ and 1$\frac{15}{16}$ ounces each, 22 ounces to the dozen, or 41$\frac{1}{4}$ pounds net to the case.

Eggs weighing less than 1$\frac{5}{8}$ ounces each, or 19$\frac{1}{2}$ ounces to the dozen, or 36$\frac{1}{2}$ pounds net to the case, are called "peewees" and are the smallest grade.

The grade of an egg is not affected by its shape unless it is extremely abnormal. Slight bulges in the shell, moderate wrinkles, creases or roughness are not serious enough defects to exclude eggs from their normal grade, but very long or round eggs do not stand shipping well, as they do not fit the fillers and, therefore, are more easily broken.

The color of an egg does not affect its food value but it may change its market value. The New York market, for example, prefers a white-shelled egg, while Boston demands one with a brown shell. White eggs are generally more closely graded as to color than brown ones. Fancy white eggs should be chalk-white and free from any tint of creaminess. Fancy brown eggs should be a fairly even dark brown. Uniformity of color is more important with brown eggs than the exact shade. White and brown eggs should not be marketed together.

Eggs should be spotlessly clean to sell best. Moreover, the quality of dirty eggs is more likely to be impaired by bacterial infection, due to the fact that various types of bacteria find a lodging place in dirt and filth. Eggs can be washed but this takes time and increases the danger of spoiling. The best plan is to prevent eggs from becoming dirty by approved methods of sanitation in the houses.

Thin-shelled eggs are readily distinguished, when candled, by the porous and colorless spots appearing on the shells.

Uniformity in size, shape, color and quality is an important factor in the sale of eggs because it affects their appearance.

Uniformity can best be accomplished by keeping one breed and then breeding for the qualities desired.

The grading of eggs according to outside appearance is difficult because the real value depends on inside quality. Eggs are usually graded as follows, depending, of course, on their size, color, shell condition, and interior quality: specials, extras, standards, trades, mediums, pullet, dirties, and checks. Different markets vary in the requirements for the various grades and the number of grades. Usually the larger the volume of eggs received the more attention is paid to grading. Success in the sale of eggs in any market depends to a large extent in finding out its requirements and catering to these demands. It is also well to remember that a product of the finest quality, regularly well graded and packed, is more likely to bring the top price.

HANDLING EGGS ON THE FARM

The eggs should be gathered at least three times daily; four times is preferable. Frequent gathering prevents eggs from becoming dirty, broken in the nest, heated or frozen. Most important of all, it helps to maintain the quality of the eggs.

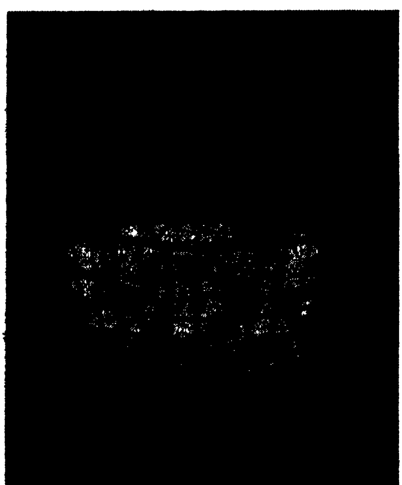


Fig. 102. A wire egg basket for gathering and holding eggs before packing. Eggs cool quickly in such baskets.

The eggs should be placed in a clean, cool cellar immediately after gathering, where the temperature is between 50° and 60° F., and the relative humidity is 70 per cent or above.

Wire baskets, perforated pails, or ventilated baskets

make the best containers. Careful tests show that eggs cool down to room temperature from one-and-one-half to two times as fast in such containers as in ordinary metal pails.

A good carrier should be rigid enough on the sides and bottom when filled with eggs and lifted by the handle not to bend sufficiently to crush the eggs by pinching them together.

Eggs, like all food products, are sold largely on their appearance; therefore, they should be spotlessly clean.

When eggs are only slightly dirty, such spots can be removed by wiping them off with a clean damp cloth.

Many poultry-keepers screen the dropping boards by fastening wire under the perches, so that the hens cannot walk in the droppings. This prevents the hens from dirtying their feet and later soiling the eggs. (Figs. 26, 27.)

Accumulation of filth in the nest may be prevented by arranging the nests in such a way that the hens are not permitted to roost in them during the night; also, by building nests in sections which can easily be removed and frequently cleaned.

Most important of all—the nests should be at least 7 or 8 inches deep. This makes it possible to have a deep bed of nest material, thus avoiding bare-bottomed nests which increase the number of broken and dirty eggs. One nest should be provided for every 5 or 6 hens.

Planer shavings, fine fresh meadow hay, or oat straw, mixed with shavings make the best nest material.

Keeping the floor dry and reasonably clean, keeps the feet of the birds clean, and this in turn prevents the eggs from being soiled in the nests.

To keep hen's feet from getting muddy, cinders or sand should be used to fill any holes in the yards near the house. Besides this, it is advisable to have the openings where hens go in and out of doors some distance from the nests, so they will have cleaner feet when they reach the nests.

Of course, this is no problem if the birds are confined, as is the practice on most commercial farms today.

Normal eggs have strong smooth shells which will stand ordinary handling with very little breakage. In every flock, however, there are hens that lay eggs with hard yet very thin and porous shells. This may be due to several reasons of which feeding is the most important. Such eggs allow very rapid evaporation and give bacteria a better opportunity to enter. When they are very defective they should be used at home or sold locally, as they are likely to become checked or broken if shipped. If quite a number of eggs from a flock are affected, the cause should be determined if possible and corrected.

Very badly soiled or stained eggs may be scraped with a knife and then cleaned with sandpaper. Dry-cleaning is best. As has been explained, cleaning the eggs in water or even allowing clean eggs to get wet is objectionable, particularly if the eggs are to be stored.

Sanding machines suitable for cleaning eggs are on the market. They are fairly satisfactory but expensive.

Eggs should be rubbed as little as possible, for rubbing gives them a shiny appearance which is usually considered an indication of age or poor quality.

It requires about 12 hours to cool eggs in a wire basket from 100° F. to 50° F. in still air. This time is reduced to 2 hours in circulating air from a fan. It is not good practice, therefore, to pack eggs in cases until they have cooled 12 hours or more in still air, or from 2 to 3 hours in circulating air. On most farms the eggs gathered today should be packed in cases tomorrow.

Since the cases with fillers and flats hold heat or cold, and change temperature slowly, they should have been in the cool room more than a day to be of room temperature when the eggs are packed.

When the temperature outside the holding room is several degrees higher than the temperature in the holding room, the eggs should be packed in the cases in the holding room. If

this is not done, the eggs will sweat when removed to the outside air. It will then be difficult to pack them without soiling them and the moisture makes a good place for bacteria to lodge.

THE EGG ROOM

An underground room with a building above is usually most satisfactory for an egg room. Just enough ventilation is needed to keep the air fresh and clean. Too much ventilation causes evaporation of the eggs and makes it difficult to keep the temperature down and the humidity high. One small window near the ceiling partly open, but shaded to keep the sunshine out, usually provides sufficient ventilation. In the summertime the window and door should be left open on cool nights, but closed during the day. This keeps the room cooler and conserves the humidity. The various ways of providing moisture in an egg room are described on page 267.

It is desirable from time to time to clean and disinfect the egg room, particularly the floor, to prevent stale odors and molds.

When water stands on the floor of the egg room, a slatted platform three or four inches high keeps the bottoms of the cases from becoming wet, as well as the shoes of the operator. An electric fan directed on the floor of such a room for a few hours each day increases the humidity in the air.

Oftentimes a satisfactory egg holding room may be made by partitioning off a room in the house cellar. The walls of this room should be well insulated and the door carefully fitted to keep the cool and moist air from escaping. A well-protected outside entry to the room is desirable.

Sufficient room should be provided not only for several baskets of eggs as they are gathered, but for both filled and empty cases, benches, egg grader, egg cleaner, cooler, and any other necessary material.

PACKING AND SHIPPING EGGS

Eggs should be shipped as promptly after they are laid as possible. This is particularly true in hot weather when the producer does not have a suitable place in which to hold them. They should never be held longer than one week. On large poultry-farms it is customary to ship two or three times a week.

Unless the customer wants eggs delivered on Saturday or Monday, it is poor practice to ship near the last of the week, as they are likely to be kept over Sunday in the hands of the transportation company, often under unfavorable conditions. Tuesdays and Thursdays are generally considered the best market days.

If it takes several hours for the eggs to reach their destination and they can be shipped either in the morning or the evening, the latter is to be preferred, for they will then arrive on the market in the morning ready for prompt delivery. Night shipping in the summer is cooler.

Fig. 103. Neat cartons for private trade.

Many poultry-keepers prefer to ship their eggs by truck when this service is available. The truck usually picks up the eggs at the farm and exchanges empty cases for the filled ones, thus saving the time and expense of delivering the eggs to the

railroad station. A change is made for the case as well as for the delivery of the eggs. Some trucks are refrigerated.

Whether one ships by express or truck is largely a matter of convenience and cost. The method of transportation that provides minimum and careful handling of eggs and prompt delivery to the customer is the most desirable.

When eggs are shipped by express, the charge may be paid either by the shipper or the receiver. Ordinarily it is customary for the receiver to pay the charge but sometimes, when a special deal is made or to avoid mistakes in the charge, they are prepaid. In either case, there should be an understanding with the receiver to file all claims for breakage or other damages immediately with the express company. By this plan, collection of claims is less difficult.

If the eggs are sold locally, they can be packed in regular thirty-dozen cases or in cartons holding one dozen eggs each. Neatly printed cartons (Fig. 103) are the most desirable, attractive and convenient packages for private trade. The two-by-six cartons, two eggs wide and six eggs long, are the best as they will fit snugly into the ordinary egg-case.

Cartons should carry the name and address of the producer and a brief statement to the effect that the eggs are "new laid." It is also advisable to mention that the eggs are produced by pure-bred hens kept under sanitary conditions and fed on clean wholesome feed. The carton may be sealed, but it is not wise to date either the eggs or the seal. Eggs packed in cartons in this way should be candled for blood spots and other defects.

Home made returnable egg cases with a hinged top, clasp and lock may be built and used where case lots of eggs are delivered to local points. Such cases will save considerably in the cost of cases. Filled cases can be exchanged for empty ones each time a delivery is made. If well made, they should last for years. The farm name may be advertised on the cases.

Eggs of different sizes and colors should be packed sepa-

rately in the case, if there is not enough to fill full cases. A record of the number of dozens of each classification should be made on the shipping card. Grading in this way not only makes a good impression on the buyer, if it is well done, but tends to increase the returns for the case. When no grading is done, the price is likely to be based on the least desirable eggs in the case. When possible it is always advisable to ship full cases of one size and color. Mixed cases usually sell at a lower price as the dealer must find a buyer who wants such a case, or repack it.

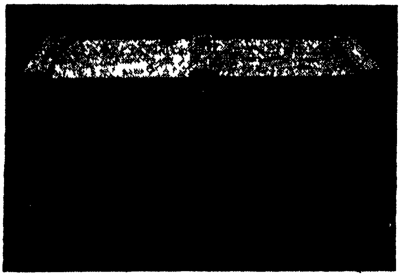


Fig. 104. A home-made returnable egg case.

Egg scales should be kept near at hand when the eggs are packed to check individual weights when in doubt. With practice, most persons can tell the weight of most eggs without weighing them.

On the larger farms the use of an automatic egg grader, although expensive, saves time in packing.

Parcel-post shipments. Near the large cities the number of eggs shipped direct to consumers or dealers by parcel post is increasing. The packages for this purpose must be strong to protect the eggs from breakage, and of light weight to reduce the cost of postage. Parcel-post packages are made to accommodate one or more dozens of eggs. Where the packages are not to be returned to the shipper, corrugated pasteboard boxes are most common because they are cheaper, but when the packages are returned, aluminum or wooden containers are more serviceable.

Eggs will be accepted by the postal authorities for parcel-post shipment in ordinary thirty-dozen cases. The cases, however, must be strong and sound and properly packed. This method of shipment is of great value to near-by shippers, espe-

cially in case of emergency when express and freight shipping facilities are suspended.

The cost of postage is the same to all points within the first and second zones, or within 150 miles of the sending post-office. The rate is 8 cents for the first pound and 1.1 cents for each additional pound.

Usually it does not pay to ship eggs outside the second zone, because the postage charge for the initial pound, being more, the total cost of shipping a dozen eggs is greatly increased. This is particularly true with small packages containing one or two dozens because the weight of the container is proportionately greater for each dozen eggs than when a larger number is sent in one package.

Eggs shipped by parcel post may be insured against loss or breakage. It is natural to expect that insured packages will receive more careful handling and, therefore, arrive in the hands of the customer in better condition.

The rules and regulations for shipping eggs by parcel post may be obtained at any post-office.

Case shipments. (Fig. 105). When large quantities of eggs are shipped to distant points by railroad or automobile express, the standard thirty-dozen wooden case is the best package. Under such conditions new cases with new flats and fillers are the best. Fiberboard cases are also used but are not as popular.

Most eggs shipped from the farm to local markets are packed in used wooden cases with used flats and fillers.

In packing eggs in a case, two pulpboard flats should be placed on the bottom, back to back with the cup side up, a filler put on this and the eggs placed in the filler with the small end down. The flat acts as a cushion for the ends of the eggs and prevents breakage. On top of the bottom layer or filler full of eggs, another pulpboard is placed flat and four more layers of eggs packed in the usual manner, using fillers with a flat between. On top of the fifth layer, two more flats are put back to back for protection on the top. When both

sides are filled in the same way, the cover is laid on and nailed.

The cover should be nailed at the ends, but *not* in the center. Four nails on each end of a one piece cover is sufficient.

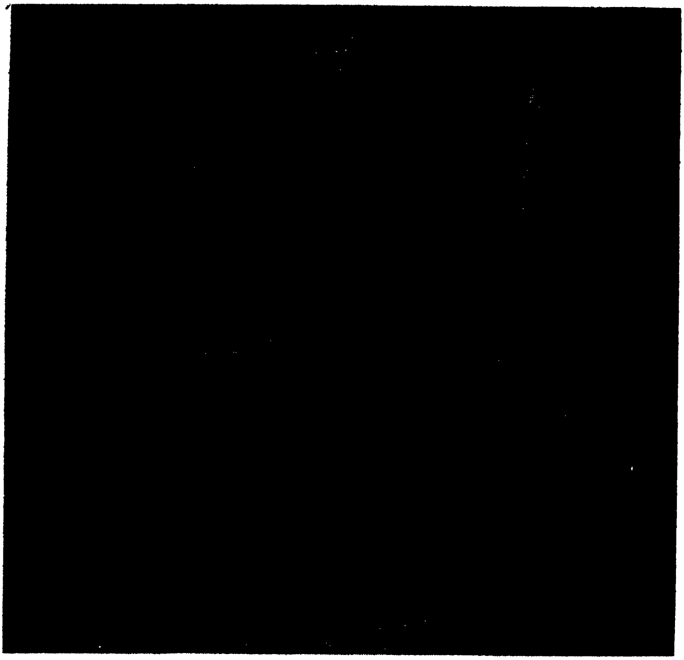


Fig. 105. A case showing proper method of packing with pulp flats and fillers (A) or strawboard flats, pads and fillers (B). Note shipping card (C) on end. Pulp-board flats and fillers are now used almost entirely.

Nailing in the center makes it difficult at the market to remove the cover for inspection without breaking it.

Do not stuff newspapers or other material in between the sides of the case and the filler. This breaks the filler ends, crowds the eggs together too tightly, increases the danger of breakage, and spoils the appearance when the case is opened.

Second-hand cases should be inspected carefully before the eggs are put into them, to see that they are properly nailed on the sides and bottom.

Extra flats and fillers should replace weak, broken or soiled ones.

If there are extra long eggs which extend above the filler, they should be packed in the corners of each filler or all together on the top layer where they can be protected by nailing a cleat on each end and the center of the case to raise the cover a little. Extra deep fillers are also recommended for the top layers when there are very many such eggs.

Always pack the eggs with the small end down. Not only will they look much better when the case is opened, but the air cells will be firmer and the yolk shadows appear better when candled. The air cell is usually at the large end of the egg with the yolk and white beneath. Consequently, there is less pressure against the air cell in transit in this position than when the eggs are packed with the small end up.

The name and address of the receiver and shipper should be marked plainly on each end of every case.

Hatching eggs. Eggs for hatching purposes are shipped in parcel-post packages, baskets, or regular thirty-dozen egg-cases. When they are shipped in baskets each individual egg must be wrapped in excelsior or newspaper and placed in layers with a thick pad of excelsior on the bottom and between each layer. A cushion of excelsior with burlap over it makes the cover. Regardless of how they are shipped, each package should be plainly labeled: "Eggs for Hatching! Do Not Delay!" When 100 or more eggs are shipped, it requires less time in packing and is safer to ship them in a thirty-dozen case. The regular number of flats, fillers and pads are always used, even if only a part of the capacity of the case is utilized.

When a valuable product, like hatching eggs, is shipped by express, its value should be declared to the express company so that a suitable amount can be claimed if they are lost or destroyed. When hatching eggs are shipped by parcel post they should always be insured. Before the eggs are packed they should be candled to remove those with defective shells.

METHODS OF SELLING EGGS

The producer may dispose of eggs by any of the following agencies:

(a) The consumer, directly through a curb or public market, parcel post, or home delivery.
(b) Retailers (city grocers).
(c) Bakers and confectioners.
(d) Hotels and restaurants.
(e) Jobbers (small wholesalers).
(f) Large packing houses.
(g) Commission merchants.
(h) Wholesalers.
(i) Country stores and milk stations.
(j) Country collector (huckster).
(k) Cooperative associations.
(l) Egg auctions.

Eggs, on leaving the farm, may also pass through any combination of these agencies. In fact, eggs traded in at the country stores may be sold to the country collector who sells to the wholesaler or through a commission merchant. They may then be resold in smaller lots to jobbers who supply retailers, bakers, hotels, or restaurants after which the consumer finally receives them. Usually, the more directly the producer can deal with the consumer, the better price he can secure for his product. The consumer likewise usually benefits by a closer contact with the producer because he stands a better chance of securing a higher quality product, since it does not have to pass through so many hands before it reaches him.

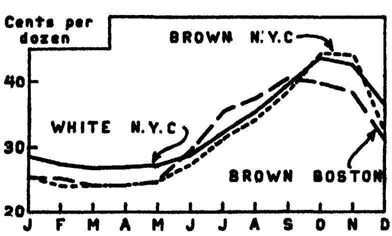


Fig. 106. Comparison of prices of Best Brown Eggs at Boston with Best Brown and White Eggs at New York City (Specials, monthly 5-year average 1937–41).

The price of eggs (Figs.

106, 107, 108). The price of eggs in any market is determined by the supply and demand. In all markets of sufficient size, either private or government agencies report the result of actual sales and private conversations with dealers.

In New York City, eggs of all grades are bought and sold each morning on the floor of the New York Mercantile Exchange. Dealers or their representatives are on hand to watch the offers and bidding and discuss market conditions with each other and with the market reporters. "The prices for the day" are the result of a careful consideration of the firmness, or weakness, of the selling on the Exchange, the attitude of the buyers and dealers and their willingness to buy and sell, the amount of receipts, weather conditions, holdings of eggs, and the like.

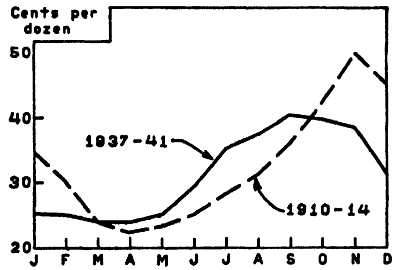


Fig. 107. Seasonal variation in the price of Best Brown Eggs at Boston (Specials, monthly 5-year average).

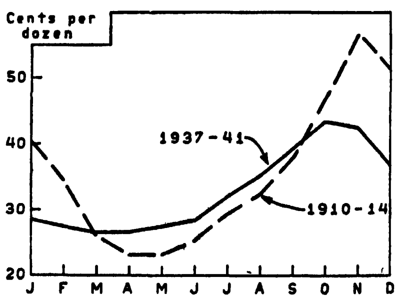


Fig. 108. Seasonal variation in the price of Best White Eggs at New York City (Specials, monthly 5-year average).

Price reporting is difficult and requires wide experience, good judgment, honesty and fairness.

THE STORAGE AND HOME PRESERVATION OF EGGS

Cold storage. Practically all farmers and poultrymen sell their eggs immediately, probably because they need the money at once. A few, however, are in a position to take advantage of cold storage facilities, when they are easily accessible, to hold over some of their cheap spring eggs until the season of higher

prices in the fall. This is good business under the proper conditions and is worth investigating by any large producer.

Many banks or licensed warehouses will loan money to their customers on negotiable warehouse receipts as collateral, and,

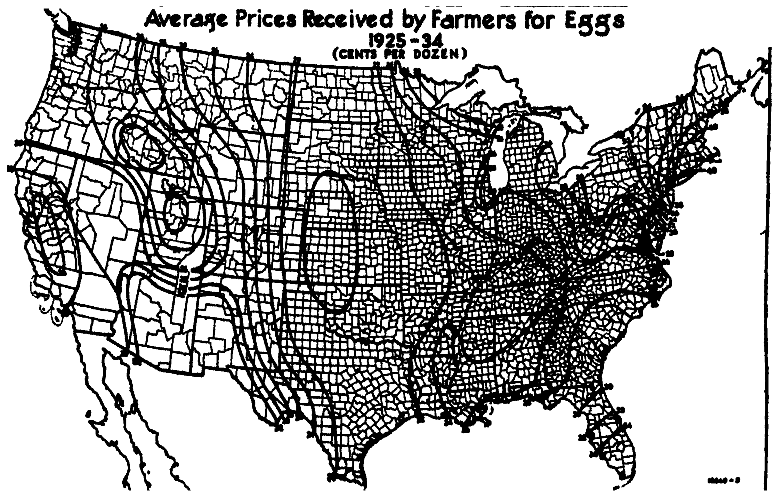


Fig. 109. Regional variations in prices received by farmers for eggs. (Courtesy of Farm Credit Administration.)

if requested, will also look after the insurance on such eggs. With such service, the customer is relieved of practically all responsibility while the eggs are in storage and often can have the use of a large proportion of the value of the eggs as well.

Eggs for storage should be fresh, clean and infertile and packed in new cases with new flats and fillers to avoid the development of molds, mustiness, bad odors and flavors and deterioration by bacteria.

The temperature of the cold storage room is held at 29° to 30° F. and the relative humidity at about 90 per cent.

OIL PROTECTED EGGS

Recently improved methods of treating the shell of eggs with warm or cool oil have been developed which partially

seals the pores of the shell thereby preventing evaporation and loss of carbon dioxide. Oiling makes good eggs keep longer; it also makes them keep better. Oiling should be done as soon after the eggs are laid as possible, and before they are shipped. Retailers have observed that new-laid eggs treated with oil will maintain their freshness better during ordinary market operations.

The oil treatment of eggs is growing in popularity in commercial channels.

FROZEN EGGS

Freezing is one of the best ways of preserving eggs. About one-third of the eggs stored annually in the United States are frozen. In the beginning mostly low quality eggs were used but experience soon demonstrated that clean sound eggs of good quality were essential in the preparation of good frozen egg products.

In recent years because of the demand for high-grade frozen eggs, dealers have found it profitable to supply high-quality eggs for this purpose.

Separated yolks, whites or mixed whole eggs are preserved by freezing. Bakers, confectioners and other commercial users prefer eggs in this form because they are more convenient.

Freezing checks the growth of bacteria. This, together with the ease in which they can be kept in the frozen state, gives them a dependability desired by the makers of such frozen foods as ice cream, as well as by bakers. Frozen yolks are generally favored for the making of mayonnaise.

The demand for frozen egg products is increasing. Thirty dozen average sized eggs yield from 34 to 36 pounds of whole egg mixture, or 15 pounds of yolk and 20 pounds of white.

DRIED EGGS

A considerable volume of dried eggs have been consumed in the United States for several years. Most of this product came

from China until cut off by the war with Japan. Wartime requirements have greatly increased the demand for dried eggs and this expansion undoubtedly will extend over into peace times. During 1941 45,280,000 pounds were produced; for the first 10 months of 1942, 195,000,000 pounds.

Dried eggs can be stored for many months at comparatively high temperatures. Because of this and the fact that they do not need refrigeration, they are easy to handle and convenient for long-distance shipping.

There are three ways in which eggs are dried: the belt, spray, and pan methods. The processes are similar to those used in drying milk.

The whole egg may be dried, or the yolks and whites may be separated and dried. The whole egg is used in bakery products, the yolk in prepared flours and the albumen by confectioners.

It requires 36 to 40 average-sized eggs to make 1 pound of dried eggs; 2¼ pounds of liquid yolk, and 7½ pounds of liquid white to produce 1 pound of each in the dried state.

HOME PRESERVATION

The preserving of cheap spring eggs for use in the home in winter, when fresh eggs are high, is good economy whether or not a flock of hens is kept.

Of the various ways of preserving eggs for household use, the water-glass method is generally considered the best. The following materials are necessary for preserving fifteen dozens of eggs:

One 8-gallon earthen crock, or jar.

¾ quart of commercial water-glass.

9 quarts of boiled water.

Carefully cleanse the crock and after the boiled water is cool, pour it into the jar and add the water-glass. Thoroughly mix the two with a long-handled spoon or a ladle made from a clean piece of board. Carefully lower the eggs into the solution.

Be sure that the eggs are fresh, clean and sound. Cracked eggs will not keep well and may break in the jar while being removed. Candle the eggs to be sure that they are not defective. Usually it is better to fill the crock at once, although eggs may be added as they are laid. Be sure that there is enough liquid to cover the eggs completely. Keep the crock covered and in a cool place.

Eggs preserved in water-glass will keep in excellent condition for several months. They can be removed as needed and are suitable for almost any purpose except boiling, which breaks open the shell unless a small hole is first made in it with a pin. Eggs to be held in water-glass should not be washed.

SHIPPING DAY-OLD CHICKS

Many breeders do a large business in day-old chicks. As soon as the chicks are dried off in the incubators and can stand, they are placed in corrugated pasteboard boxes for delivery. The box should be well ventilated by means of small holes on the sides near the top. The number of these holes depends on the weather conditions at the time of shipping.

The largest sized box on the market will carry 100 chicks and is divided into four compartments accommodating twenty-five chicks each (Fig. 110). Several kinds of chick boxes are sold. One that is strong and easy to handle should be chosen.

Before the chicks are boxed, a pad of excelsior is put on the bottom of each compartment to make it easier for the chicks to stand, as well as more sanitary. Then the cover is securely fastened in place, and strips of wood 1 inch wide by ½ inch thick are nailed around each box. This ensures better ventilation when they are stacked in the express car, if there are several boxes in the shipment.

Chicks may be shipped by parcel post or by express. For points within the second zone, parcel-post rates are usually cheaper and deliveries are often quicker than by express. Very valuable chicks should be insured if mailed, or the valuation

declared if shipped by express. On account of the possibilities of delays, it is not advisable to ship chicks distances which will

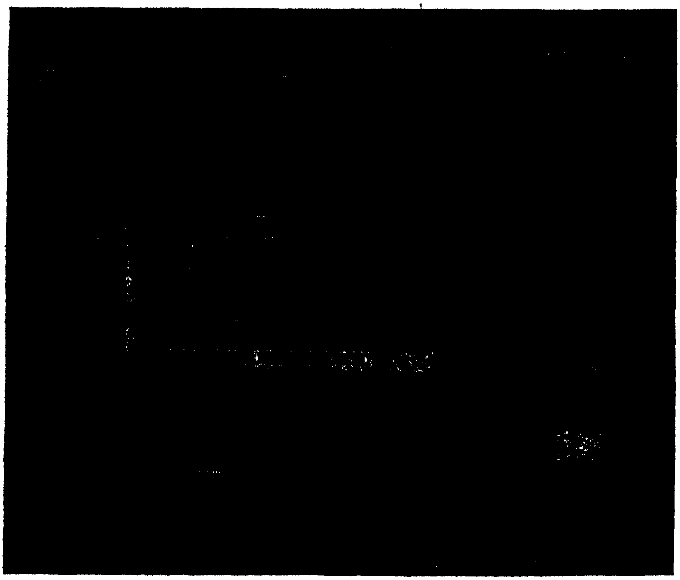


Fig. 110. Approved shipping crates for live poultry, and cardboard box for chicks.

require more than forty-eight hours in transit. The chicks should not be fed before they are shipped.

SEASONAL PRODUCTION

The season of the year has a marked influence on production (Fig. 111). According to the United States Department of Agriculture, 48.7 (1935–39 ave.) per cent (or practically half) of the annual egg crop is produced during the months of March, April, May, and June, when the weather conditions are most favorable.

The supply of eggs during these months is greatly in excess of the demands for immediate use. Fortunately, the storing of eggs helps to take care of this glut and tends to stabilize the

price of eggs throughout the year. There is still, however, a considerable variation in prices between spring and fall, and if a producer wishes to increase the annual price of his eggs, or keep it high, there is no better or more practical plan than to try to obtain a high yield of eggs during the season of highest prices. This can be accomplished by paying greater attention to the season of the year when the chicks are hatched, breeding, age of the birds, feeding and housing.

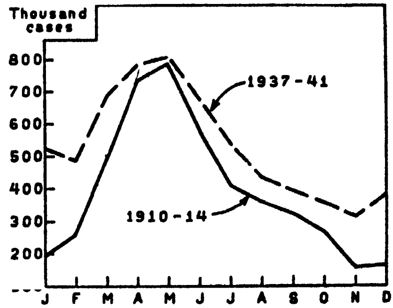


Fig. 111. Seasonal variation in receipts of eggs at New York City (monthly 5-year average in cases).

XV. Marketing Poultry

UNTIL recently, very little attention has been given to specialization in table poultry throughout the United States. The reason is probably that most farmers and poultrymen have found it more profitable to keep hens for egg production rather than for meat purposes. In the past, the poultry sold being largely a by-product in the production of eggs, little attention was paid to selecting breeds best adapted to meat

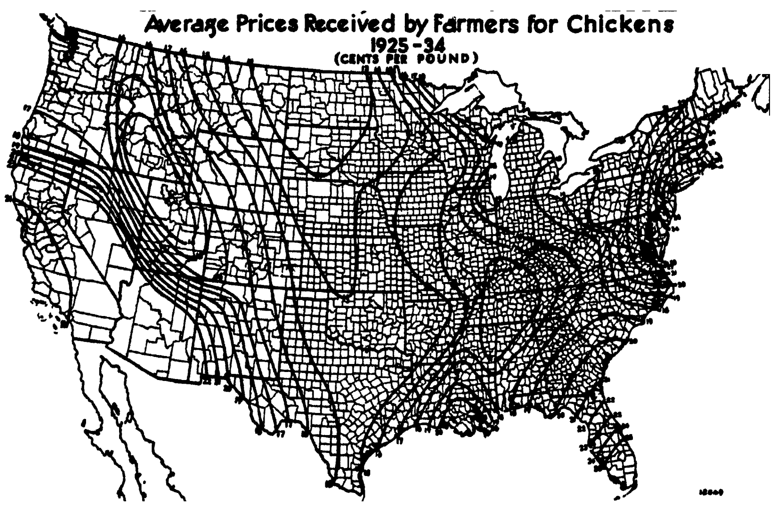


Fig. 112. Regional variations in prices received by farmers for chicken. (Courtesy of Farm Credit Administration.)

purposes; and outside the packing houses in the middle western states, where poultry was bought in large numbers from farmers and fattened, very little was done to condition poultry sold for market purposes.

Today the production of poultry meat is changing. There is more specialization. Many poultrymen of experience say that there is more profit in selling dressed poultry or poultry products than there is in eggs. Surveys and scientific investigations of meat-production problems are helping the farmer to put a better and more profitable chicken on the market.

There is a constantly growing demand in all parts of the country for table poultry of the finest quality, and, for those who are located near large cities or fashionable resorts and are interested in this phase of poultry-keeping, a good opportunity to develop a business of this sort presents itself.

Some breeds are much better adapted for meat purposes than others. These differences are discussed in Chapter III.

FACTORS AFFECTING THE PRODUCTION AND SALE OF MARKET POULTRY

Age and maturity. Most consumers prefer poultry that is young. It is assumed that young birds will be more tender, less stringy, and better-flavored. Age is usually determined by the length of the spurs, by scaly legs, long toe-nails, long hairs on the body, and a dry loose condition of the skin. The age of Leghorn broilers is partially told by the size of the comb. Scaly legs in particular, even though the legs are not used, spoil the appearance of a bird and may result in a lower price. A scaly-legged chicken does not look good to the customer.

Female chickens of the same age and breed have finer, more tender flesh than males. They are more likely to be fat and plump.

American markets prefer yellow-skinned poultry to white, but in Europe white-skinned breeds are in demand because they are considered to have better quality of flesh. The color and condition of the shanks and skin are important. The preference is for a deep yellow, as it is considered an indication of good health and vigor. Black, slate-colored, or feathered shanks

are often discriminated against by particular customers. Broilers must be well feathered on the back.

White-plumage birds are popular with producers who cater to private trade, because they dress cleaner and do not have the dark or black pin feathers found on dark-feathered birds.

To sell well, poultry must be fat, of good quality, and healthy. The keel bone should be well covered with flesh and the breast deep-meated. The carcass should be carefully dressed and neat in appearance.

In growing poultry for meat purposes, size of body, rapidity of growth, rate of feathering, livability and type are important factors because they affect the market appearance of the birds and the cost of producing them. Experiments at the New York State Experiment Station at Cornell University, and other stations, show that these qualities are largely controlled by careful breeding and selection.

CROSS-BREEDS FOR MEAT PURPOSES

Several investigators have presented data to show that cross-breeding does increase the growth rate and tends to decrease the mortality, especially in broiler production. The crossing of some breeds gives better results than the crossing of others. Apparently, crossing Leghorns with heavier breeds, such as Rhode Island Reds, has more limitations than crosses of the heavy breeds. One advantage of this cross is its white plumage.

SEXED CHICKENS FOR MEAT PURPOSES

Now that sexed chicks are available, it is to the advantage of the meat producer to buy male chicks. Many investigators have pointed out the difference in weight at different ages between males and females. The New Jersey Experiment Station recently reported differences of 15 to 25 per cent at ages of 8 to 16 weeks, and 20 to 30 per cent at 18 to 20 weeks, regardless of breed. Most poultry keepers prefer cockerels of the heavy breeds as they sell for higher prices on most markets.

There is a little evidence which indicates that cockerel chickens are slightly more efficient in the utilization of feed for growth than are pullets.

Two investigators have observed that pullets grow more rapidly when reared by themselves, and it is probable that both cockerels and pullets will grow more rapidly if they are segregated at hatching time.

RANGE VS. CONFINEMENT OF MEAT BIRDS

Jeffrey states:[1] "It is probably true that, if conditions of temperature and feeding are kept uniform, there is not much difference in the growth rate of chickens when raised on free range, in confinement, or in battery brooders. Buckner, Martin, and Insko found no great differences in the rates of growth of White Leghorns raised in colony brooder houses with access to blue-grass range and direct sunlight and those raised in battery brooders for the first 22 weeks. Data at this station (New Jersey) fail to indicate significant differences in the body weights of White Leghorns raised in colony brooders and those raised in complete confinement at the ages of 12 and 24 weeks. Harshaw reported that birds reared on range had a higher percentage of breast muscle, leg muscle, and total edible portion than those reared in confinement."

EFFECT OF DIFFERENT CEREALS ON THE QUALITY OF POULTRY MEAT

Two investigators have compared the quality of poultry meat by eating tests when rations containing large amounts of corn or wheat or barley or oats were fed. Meat produced from the corn ration was superior in flavor, aroma, amount of juice, texture, and tenderness of flesh. Corn gave a better distribution of fat throughout the body and in the flesh. These observations indicate that corn is outstanding as a fattening cereal.

[1] New Jersey Agricultural Experiment Station Bulletin 656.

LIVE VS. DRESSED POULTRY

Most of the poultry marketed by producers throughout the United States is sold alive. This practice is popular because the average producer does not have the time, equipment or skill to prepare dressed poultry.

Furthermore, it is questionable whether it is advisable for the average producer to dress poultry to be shipped some distance to market in competition with the carefully graded product of the packing houses. In most cases the number, size and quality of the birds killed on the farm at one time does not afford much of an opportunity for grading, which is so necessary to meet competition in the larger markets at present if good prices are desired.

Near-by markets are the best for dressed poultry, because the producer can quickly deliver his product directly to the buyer, thus avoiding the labor and cost of the package in shipping. Local markets are not so fussy about grades, and, if private trade is catered to, the customers are principally concerned with the appearance, size and quality of the individual birds they receive. When there is a large enough spread in prices between live and dressed poultry, and a good local market, it will undoubtedly pay for those who have the facilities and the inclination to sell the surplus stock dressed.

MARKETING POULTRY ALIVE

Live poultry is sold at the farm to dealers; shipped by express or truck to a near-by market where it may be sold by a cooperative agency or dealer on commission or purchased outright by the dealer, or it may be sold at retail or wholesale by the producer on a public market or to dealers, stores, hotels, clubs or individuals. If the birds are sold at the farm, it requires less labor in marketing, no coops, no loss in weight, and a chance to check the accuracy of the weighing. A poultryman

may receive more if he is a good salesman and does the selling on the market himself, but it requires more time and labor. There is a growing tendency in all parts of the United States to sell poultry alive at the farm.

Poultry grown in production areas some distance from the large markets is collected by local dealers or packers at a convenient point and shipped to market in specially built trucks or freight cars. Facilities for feeding and watering the birds enroute are provided. At the present time more poultry arrives in the New York market by truck than by all other ways combined. Truck shipments are favored by the farmer and the dealer alike. They save time, travel, and expense for the producer, and are more convenient and direct for the dealer.

It is unwise to ship sick birds to market, or those in poor condition. They are always discarded when they arrive on the market. The producer pays the transportation charges on such culls, with little or no returns. Furthermore, the buyer is likely to be influenced more by the poorest birds in the coop than the best, and this drags down the grade and the average price of the whole lot.

SHIPPING LIVE POULTRY

Coops for shipping live poultry may be home-made or purchased (Fig. 110). In either case they should be strong, light, high enough for the bird to stand comfortably, and convenient to handle and operate. A standard-sized coop is 3 feet long, 2 feet wide and 1 foot high. Such a coop will accommodate comfortably from twelve to fifteen mature birds, depending on their size, fifteen to twenty broilers, or ten to eighteen head of ducks. For geese the coop should be 16 inches high, while for turkeys one 20 inches high is necessary. From six to ten geese or five or six turkeys can be shipped in a standard-sized coop. If larger coops are made, partitions should be placed in the center to prevent crowding.

In shipping, the temperature should be taken into consideration. In warm weather a smaller number of birds should be shipped in each coop than in cold weather. Over-crowding should be avoided at any time, for this is likely to cause more shrinkage in transit.

Live poultry should arrive or be delivered on the market early in the morning. Of course the best time of day to ship depends to a large extent on the distance from market. It is always best to have the shipment on the road as short a time as possible, but if it takes several hours to reach the market, and there is a choice between shipping in the morning or the evening, the latter is preferable as there is likely to be less shrinkage, especially in warm weather, because it is quieter and cooler at night. If the night shipment arrives on the market early in the morning, some shrinkage may be prevented by early weighing.

It is important to be familiar with the requirements of the market to which birds are shipped. Live poultry should never be shipped to arrive on Saturday, as little or no business is done on some markets on that day; and the birds will have to be held over until Monday. During this period they lose weight and some may become crippled from staying in the coops so long.

Tuesday, Wednesday and Thursday are the best market days in New York City. The greatest demand for live poultry in the New York area comes during the Jewish holidays. These occur in March, April, September and October each year. Since it is estimated that the Jewish people consume about 80 per cent of the live poultry shipped into the New York market, it is important for producers to be informed about the dates of all Jewish holidays. This information can be obtained from market-reporters, trade journals and dealers each year. Other good market days occur just previous to our national holidays.

The kind of poultry desired varies with the season of the year. At Christmas time, for example, turkeys, fowl, capons,

and geese are most in demand; while broilers are desired on Memorial Day and the Fourth of July.

Whether poultry is shipped or sold on the farm, it is important for the producer to be fully informed on the market situation and have the latest market quotations. Market information can be obtained by radio, trade journals, state and federal market reports, and the newspapers.

SHRINKAGE IN TRANSIT

The amount of shrinkage in transit varies according to the distance the birds are shipped, the weather conditions, the method of fattening, and the handling just previous to and during shipment. Slocum[2] gives the average shrinkage of broilers in transit as 11 per cent when they were on the road for six to eight hours. Much of this loss can be averted by proper management at shipping time.

The best practice is, just before shipment, to feed the birds abundantly on well-soaked grain, preferably wheat, with plenty of water or sour skimmilk to drink. If the birds are likely to be on the road for six hours or longer, one three-pound tomato can should be filled with soaked whole grain and fastened inside the shipping crate.

Grain thrown on the floor of the coop is often wasted, for the birds will not eat it after it becomes contaminated.

SHIPPING BREEDING STOCK

On farms on which breeding is a specialty, stock is frequently shipped to customers in all parts of the United States and abroad. Especially constructed coops for this purpose may be built at home or purchased. They should be of light material, strong, roomy, well ventilated, and protected on the sides from drafts. Usually such coops are made of thin wood on the bottom and either wood or wallboard on the sides, with the top and front slatted. (Fig. 113.)

[2] U. S. Dept. Agr., Farmers Bulletin 1377.

The coops should be high enough so that the birds can stand and move around easily and comfortably. Coops which meet these requirements are built 20 x 20 inches, 4 or 5 feet long. They should have a shallow trough fastened on the front outside. This trough not only provides a place for feeding, but also prevents other boxes or crates from being set too close and thereby cutting off ventilation.

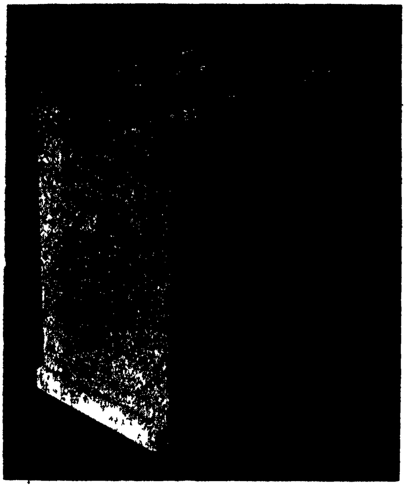


Fig. 113. A coop suitable for shipping an exhibition bird.

If there is more than one male in the shipment, each should have a separate compartment in the same coop or be shipped individually. It is usually safer and better to ship all male birds by themselves.

From two to five females may be shipped together, but the smaller the number, the better. Regular shipping crates are best for large numbers, if the distance is not too great.

Before shipping, all birds should be fed and watered. Stock that is likely to be on the road for twenty-four hours or longer should have a drinking cup and a small sack of grain fastened to the coop so that they can be fed by expressmen while in transit.

Rules and regulations for shipping poultry to foreign countries may be obtained by applying to the American Railway Express Company.

MARKETING POULTRY DRESSED

Dressed poultry is sold to consumers in one of three ways: (1) blood-and-feather-dressed, with the blood and feathers removed; (2) full-dressed or drawn, with the blood, feathers,

head, feet and insides removed; and (3) cut-up chicken such as breasts, legs, wings and backs.

Very few chickens are sold to consumers today undrawn.

SALE OF CHICKEN MEAT BY PARTS

The most recent trend in marketing chicken meat is to sell it by the part. Many markets in the larger cities are specializing in this, with the result that the sale of poultry meat has greatly increased. This method of selling is particularly adapted

TABLE XXXI

WEIGHT OF PARTS OF 23 WHITE LEGHORN COCKERELS UNFATTENED[3]

(Averaging to Weigh 4.5 lbs. Dressed)

Legs	18.3 ounces	26.5% of dressed weight
Breast	13.5 "	19.5 " " " "
Wings	6.0 "	8.7 " " " "
Neck and back	17.5 "	25.3 " " " "
Liver	1.1 "	1.6 " " " "
Heart and gizzard	2.0 "	2.9 " " " "

to metropolitan areas, where it is more convenient and economical because it eliminates waste. Also it gives the consumer a choice of parts and encourages every-day consumption. It takes chicken meat out of the Sunday-dinner class.

TABLE XXXII

SELLING PRICE OF PARTS OF FOWL AT A LOCAL MARKET

(Sale Price of Whole Fowl 25–27¢ lb., Blood and Feathers Removed)

	Price per Pound
Breasts	48¢
Legs	40¢
Backs and necks	12¢
Wings	18¢
Giblets	30¢
Liver	60¢
Fat	18¢

The price of parts. Undoubtedly the demand for poultry meat by parts will increase and producers should keep this in mind. One of the problems in the sale of such meat is the

[3] Unpublished data, G. O. Hall at Cornell University.

proper sale price for the different parts. Not much information is available which gives the per cent each part is of the whole carcass of chickens of various sizes and breeds. The following data give the information on 23 White Leghorn cockerels which averaged 4.5 pounds dressed.

The price of the various parts varies in different localities.

FATTENING POULTRY FOR MARKET

When properly fed and managed today, most poultry do not require special fattening before being marketed. Even in the producing areas of the Middle West, where it was profitable for poultry-packing plants to fatten poultry 20 years ago, it is questionable whether this practice is worth while under modern conditions.

The change is probably due to the fact that most poultry today receive better growing and fattening rations than they did in the old days. When the birds lived off the land and did not have feed before them all the time, they grew slowly and developed a framework but were not very fat. Under such conditions, confinement and forced feeding resulted in rapid gains and quick additions of fat.

Today, growing chickens usually have grain and high-protein mashes before them continually, and, if healthy, are in good condition at all times.

KILLING POULTRY FOR MARKET

The appearance and the condition of dressed poultry have a great influence on the price received; consequently, considerable care should be taken in preparing birds for market. Dry-picked birds are usually the most attractive. Scalded birds may be satisfactory for home use or for local trade, when they are soon consumed, but even then they soon discolor and appear patchy unless the picking is carefully done. The greatest objection to dry-picking is that it requires considerable practice and skill in making the proper kind of stick so that the feathers

may be removed quickly and easily without tearing the skin. Dry-picking is usually slower than scald-picking.

Methods of killing. The most common method of killing poultry is to chop off the head with an ax. This is a very satisfactory

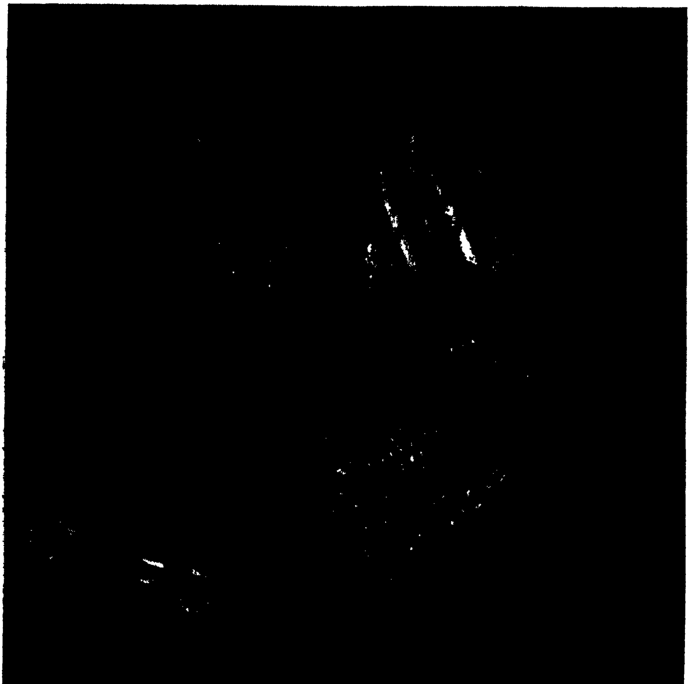


Fig. 114. Sticking a bird. Note how the head is held and the position of the knife ready to cut the blood vessels.

procedure if the bird is for home use and the feathers are removed by scalding. The bleeding is complete, but a bird killed in this manner is unsatisfactory for market purposes where the head is required and the bird is to be dry-picked.

Poultry can be killed by dislocating the neck. This method is undesirable for market purposes on account of the clot of blood which settles in the neck, but may be practiced on birds for home consumption. It is done by grasping the legs in one

hand and the head with the other; with the breast of the bird facing away from the operator and the knee as a fulcrum, the bird's head is bent backward and downward with a quick jerk until the neck bone separates from the head. As the neck bones break, the blood-vessels also break and the blood flows into the opening caused by the fracture. It is best to stretch the neck to allow sufficient space under the neck skin for the bird to bleed.

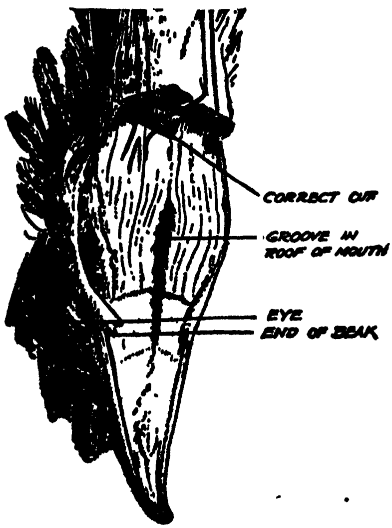


Fig. 115. Lower jaw removed, showing position of veins, anatomy of skull and location of cut. U. S. D. A.

The best method of killing a chicken is by bleeding and debraining through the mouth with a knife. To perform the operation the bird is hung head downward at a convenient height from the floor by means of a cord around the legs, or, better still, by a stiff wire shackle which holds the feet apart, suspended from above (Fig. 114). The head of the bird is grasped firmly in the left hand, with the comb resting in the palm; the mouth is then opened, and the jugular vein, which is located just below the base of the skull (Fig. 115), is cut by a downward slash of the knife across the throat. When properly done, the blood will gush forth in a steady stream as the knife is removed. One must be sure that the bird bleeds thoroughly, for a poorly bled bird will show dark blood-filled veins in many parts of the carcass, especially along the thighs, legs, and top of the wings, giving the surface a reddish cast. This not only spoils the appearance of the bird, but impairs its keeping qualities as well.

As soon as the bird starts to bleed freely, the brain is pierced

by inserting the knife in the groove in the roof of the mouth and plunging it straight back into the skull on a line midway between the eye and the earlobe. When the brain is touched, the bird will give a characteristic shudder and squawk. The knife is then twisted and removed. Experiments show that the lower portion of the brain, known as the medulla oblongata, controls the muscles of the feather tract. When this portion of the brain is hit by the knife, the muscles of the feather tract relax temporarily so that the feathers can be removed easily.

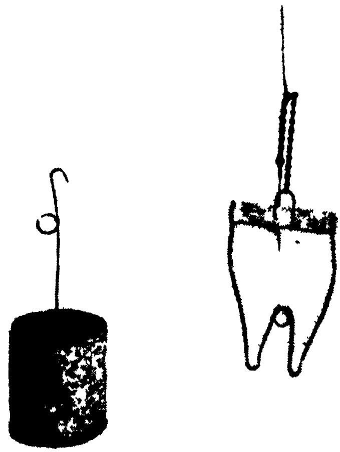


Fig. 116. A weighted blood cup and shackle for holding the feet.

Immediately after the bird is debrained, a weighted blood cup should be hooked through the lower portion of the beak to catch the blood. Sometimes a small weight is used instead of the cup.

METHODS OF DRESSING POULTRY

There are five generally recognized methods of dressing poultry: dry-picking, scald-picking, semi- or slack-scald picking, wax picking, and machine picking. Broilers may be skinned.

Dry-picking. Inasmuch as the feathers are loosened for only about a minute after the bird is debrained, it is very important that the picking start immediately and proceed in a systematic way in order to get as much done as possible during the first few seconds. No attempt is made to pluck any section of the body clean. The main point is to pluck the bulk of the feathers where they pull the hardest, or the skin is most likely to be torn, before they "set." This process is known as "roughing."

Most pickers start by holding both wings together in the left hand and use the right hand for picking. The feathers are removed in the following order: tail, main feathers of wings, breast, neck, back fluff, and legs. The tail-feathers are twisted off with a quick pull; the quill-feathers of both wings are pushed toward the body in a bunch and then quickly torn out; the body-feathers are removed in large handfuls by a rolling snappy pull. Tail- and wing-feathers pull more easily when gripped near the end. If the fingers are kept moistened with water during the picking, they will cling to the feathers better and the work will be done much more easily and rapidly.

After the "roughing" process is over, the remaining body- and pin-feathers are removed. A small dull knife is best for removing the pin-feathers. The bird is then ready to be cooled.

This method requires considerable skill and practice. Dry-picked birds keep longest and look best when on display.

Scald-picking. When the feathers are removed by scalding, the bird is allowed to hang until the muscles cease their convulsions. It is then taken down and plunged into hot water that is just below the boiling point (about 190° F.). Young or tender-skinned chickens dress better at a temperature of 150° or 160° F., while older birds need the higher temperature.

The bird is passed slowly through the water, usually about three times, care being taken not to wet the head or shanks or feet. Scalding the head and shanks leaves the comb and wattles white and makes the skin on the shanks peel. Before starting to pick, some of the feathers along the breast should be tried, or the main quill-feathers in the wing, to see whether they will come out easily. If they still stick, more scalding is necessary. One should be careful not to cook the skin, as this hurts its appearance and lowers its keeping quality.

When a number of birds are to be picked by the scalding method, time will be saved by killing and then scalding several birds before the picking is started.

Scalded birds may be picked on a smooth wooden bench, or

hanging by a string, or on the picker's lap. The essential is to do the work quickly, carefully and comfortably.

In picking scalded birds, the body-feathers should be removed in large handfuls by a gentle, twisting, rubbing motion while they are still warm and wet. A good picker will strip each wing and leg almost by a single motion. Speed is important, but it is better to do the work more slowly, and do it well, than too rapidly and have it poorly done.

This method of dressing chickens is used mostly for local trade. Hard-scald birds spoil quickly and are not suitable for storage. One of the best uses of birds dressed in this manner is in cut-up chicken.

Semi-scald picking. In semi-scalding birds the process is similar to that of full-scalding, except that the water is held between 126° and 130° F. depending on the kind of birds to be dressed. Broilers require the lower temperature. This lower temperature necessitates that the birds be dipped longer, 20 to 30 seconds. There is less likelihood of tearing the skin by this method if the operator watches the water temperature closely. The condition of the skin and the appearance of the birds are practically the same as with dry-picked birds. A recent variation in the method of picking semi-scalded or full-scalded chickens is to cover the carcass with fine, clean, dry sawdust immediately after scalding. The sawdust quickly absorbs most of the moisture and makes the picking much easier. This procedure does not injure the skin or the keeping quality of the birds. A box may be used for the sawdust.

Wax picking. The wax method of plucking poultry for market has received much attention among packing houses, turkey growers, and the larger broiler producers. The attractiveness of the finished carcass appeals to the producer as well as the packer. This method is not too simple to use, and is most practical in a packing house or plant where large numbers of chickens are being slaughtered. It is not practical on farms where less than 50 birds are killed at one time.

The procedure as practiced on poultry farms can be briefly summarized in the following series of steps:

1. Melt the wax—start an hour or so before it will be needed.
2. While the wax is melting, kill the birds.
3. Rough-pick the bird dry or by slack-scalding. Remove the quills in the tail and wings, and about three-fourths of the body-feathers.
4. Dry and cool the semi-scalded birds for one to two hours; cool the dry-plucked birds for one-half to one hour.
5. Regulate the temperature of the wax to about 130° F.
6. Holding each bird by the head and feet, dip it two to three times in the wax.
7. After draining for a few seconds, immerse the bird in cold water for about a minute or until the wax coating is stiffly pliable.
8. Strip off the wax in as large sheets as possible. Feathers, hair and some pin-feathers will be removed.
9. Reclaim the wax by melting and straining. A satisfactory method is to place the wax with the feathers in boiling water. The feathers can be skimmed off by use of a screen; most of the dirt will settle; the melted wax will float on top of the hot water and can be skimmed off and reclaimed by pouring into cold water, which will harden the wax and separate it from the water.

Both the wax and the equipment may be purchased commercially. An automatic heater to control the temperature of the wax is a necessity.

Machine picking. A new way of picking chickens has recently been developed by means of a special machine. The birds are killed and slack-scalded at the proper temperature and then held against a number of rubber fingerlike projections on a rotating drum. Most of the feathers from any kind of chicken are rubbed off in a few seconds. What feathers remain are quickly removed by hand.

This method of picking chickens is fast once the operator learns how to handle the birds. It is quite likely that the outer layer of skin will be removed in the process of picking, but this will not hurt the appearance of the carcass or cut-up meat as long as it is kept wet with cracked ice.

Picking machines are somewhat expensive now, but undoubtedly will decrease in cost as their popularity increases. They are particularly useful when large numbers of chickens are desired for the "cut-up" poultry trade.

Fig. 117. Killing a chicken by dislocating the neck. Not only is there dislocation of the neck bone, but the blood vessels are also broken. The blood collects in the neck. Chickens killed in this way must be full-dressed when sold.

Skinned broilers. Broilers may be prepared for market by skinning. This procedure has been profitably applied for years to the disposal of surpluses of broilers from experiments at the Cornell Experimental Farm.

Briefly, the work is done as follows: Eight- to twelve-week-old broilers weighing from ¾ to 2½ pounds are starved for 12 hours, then killed by dislocating the neck (Fig. 117). After the bird is through kicking, the shanks are cut off at the hock joint with a cleaver, hatchet or knife and the tip joints of the wings are removed in the same manner. The legs are pulled in opposite directions until the skin breaks on one side between the leg and the body (Fig. 118A). The fingers and thumb are inserted under the skin around the body and over the back, loosening the skin all the way around (Fig. 118B). The loosened skin is then pulled away from the body. This completely removes the skin from the back and legs (Fig. 118C). Next, grasp the bird firmly with one hand and pull away the skin on the breast between the wings and the neck by sliding the other hand forward over these sections. To skin the wings, grasp the large

wing feathers near the body and remove both the skin and the feathers by pulling away from the body (Fig. 118D).

After the skinning is finished, the legs are twisted from the body. This is quicker than cutting them off. The muscles tying

Fig. 118. Skinning a chicken. (A) First step above; (B) the second step below.

the breast meat to the backbone are torn clear just above the wings. This is done by inserting a thumb under the muscle. Following this, the forefingers of both hands are inserted in the

Fig. 118C. Skinning a chicken. Third step above; (D) the fourth step below.

front opening of the body cavity (Fig. 118E). The fingers of one hand grip the breast meat while the other hand holds the back. The chicken is then torn apart; the wings and breast

Fig. 118E. Skinning a chicken. The fifth step.

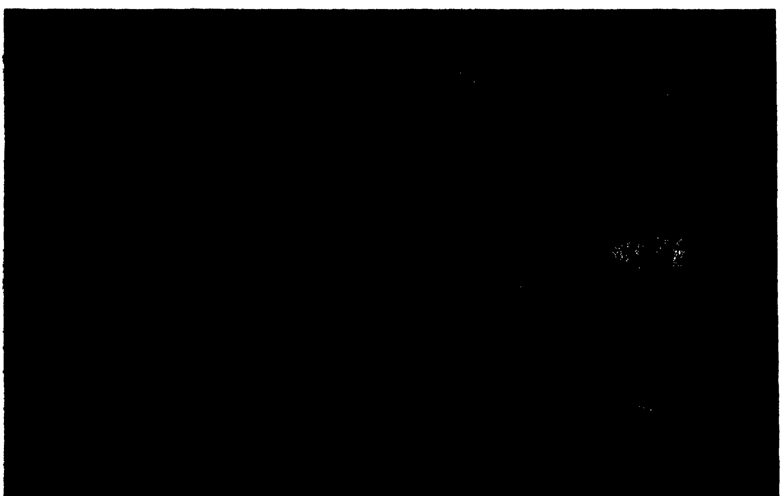


Fig. 119. Parts of the skinned chicken.

meat are in one hand while the back and intestines and neck are in the other. The gizzard, liver and heart are then detached. If the back and neck are to be sold, the intestines are removed. All the parts are thrown into ice water for chilling. In the course of an hour they are cleaned and rinsed and placed on meat platters in a refrigerator or a cool moist place.

The shrinkage from the live weight when only the breast, thighs, liver, gizzard and heart are sold, is about 55 per cent. With a little practice the average person can kill and skin 25 to 40 birds an hour; thus the cost of preparing the meat for sale is small.

Skinned chicken is excellent for frying.

Cooling. Whether the birds are scalded or dry-picked, the carcass should be chilled to remove the animal heat as soon as possible after the picking is completed. When the birds are dry-picked they should be dry-cooled in either a refrigerator or a very cool cellar. If such facilities are not easily available they can be cooled in ice water. This applies also to skinned broilers.

If they are to be shipped, chilling at a temperature between 32° and 40° F. over night is necessary.

Scalded birds, as soon as picked, may be thrown into tubs or tanks of ice water, where they should remain for one to two hours. Water-cooling lessens the keeping quality, if the birds are to be held for any length of time, but improves the appearance by plumping the skin.

Keeping the carcasses wet after they are removed from the cold water by packing them in cracked ice will also prevent discoloration where the skin has been peeled or broken.

DRAWING POULTRY

The dressing procedure for chickens, turkeys and capons that are served stuffed and roasted is the same.

Before starting to draw a bird, it should be singed to remove small feathers and hairs. This is done by passing the body of the bird through a flame of burning alcohol or gas. Printed

paper, gasoline or wood flame should be avoided as they will smoke the carcass.

To draw a fowl, cut off the feet at the knee joints with a pair of shears or a knife. If the bird is old or staggy, the eight or ten tendons which extend along the back of the shank and make the flesh of the thighs tough and almost uneatable should first be removed. This is done by placing the body of the bird on a strong table, with one foot and about one inch of the shank extending over the edge, and then breaking the bone of the shank by a quick downward movement of the hand. Proceed to twist the broken shank until the skin is broken and only the tendons remain holding it to the body. If the skin on the shank is tough, as it is likely to be, cut it lengthwise and crosswise before breaking, being careful not to sever the tendons.

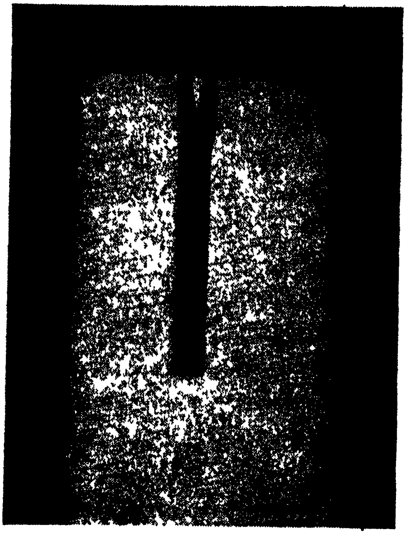


Fig. 120. A V-shaped iron for removing tendons. This iron is fastened to a post or beam.

Twist out the tendons individually from each leg with a finger (Fig. 123A), or pull out all the tendons in each leg with a special tendon puller. They may also be pulled by placing each foot of the bird in a V-shaped iron which is bent at a 60-degree angle and fastened to a post (Fig. 120).

Next, cut a slit in the skin on the back of the neck, from the shoulders to the head. Pull out the neck bone separately through this opening and sever it from the body close to the shoulders; then cut off the head, making sure that a long strip of neck skin remains. Break the tissues around the windpipe,

gullet and crop, and remove these organs. The crop is sometimes removed with the intestines.

The internal organs are next removed. Cut a short slit between the vent and the tail (Fig. 123B). Through this incision pass the finger around the intestine. Cut around the vent, loosening it from the body, and carefully remove the intestines, gizzard, liver, heart and lungs through the same opening. The intestines and crop are much more easily removed if the bird has been properly starved before killing.

Remove the oil gland at the base of the tail, and wash the inside of the bird if necessary. Lay the neck skin back over the shoulders and fasten the ends by folding the wings down over them.

Cut the muscle of the gizzard only part of the way around, being careful not to cut the inner lining; then loosen and remove the sac, if possible without breaking open the contents.

Wash the gizzard, liver, heart and neck, and place them in the body. After any blood or soiled spots have been wiped off, the carcass is ready to be cooked at home or wrapped for delivery to a customer.

PREPARING BROILERS AND FRYERS

Broilers and fryers are usually dressed in the same way except that fryers are cut into smaller pieces.

Chickens for broiling or frying are prepared as follows: Remove the shanks at the knee joint. Cut off the head, leaving the neck attached to the body. With a stout-bladed knife or shears, cut just through the bones down each side of the backbone from the tail to the shoulder (Fig. 121A). Lay open the body cavity; cut around the vent, and carefully loosen the intestines, crop, windpipe, liver, and other organs and remove them together with the neck (Fig. 121B). Remove the wishbone. Cut through the ligaments and flesh to the front end of the brown-colored breast bone (Fig. 121C). The breast bone can then be snapped out by pressing from underneath. Cut the

chicken into two parts (Fig. 121D). Wash the pieces, if necessary. Clean and wash the gizzard, liver and heart as described

Fig. 121. Preparing a broiler or fryer. (A) Above, removing the backbone; (B) below, removing the entrails.

before. Fryers are usually cut into four or more pieces (Fig. 121E).

Fig. 121C. Preparing a broiler or fryer. Above, cutting the ligaments before snapping out the breast bone; (D) below one-half of a split broiler; wing tips should be removed; wings are nicked to prevent curling while broiling.

Fig. 121E. Left, quartered fryer; right, fryer cut in smaller portions.

CUT-UP CHICKEN

It is not necessary to draw a fowl or a chicken which is to be cut up for stewing or fricassee. The procedure is as follows: Draw the tendons of older birds (Fig. 120, 123A). Remove the head, feet and oil sac. Then the wings and legs are cut off at the body (Fig. 122A). Cut through the thin tissues carefully along both sides of the body of the bird to the ribs (Fig. 122B). Then break the back by bending back the breast. Sever the back from the breast section. The entrails are left with the back. The heart is picked out and the lungs removed. The liver is carefully taken out and the gall sac cut away. The back is then cut away from the entrails. The neck is severed at the body, the wish-bone removed, and the breast meat cut into four parts. The back is also cut into two parts. The wings and legs are severed at the second joint, providing two parts each.

It is desirable, with chickens prepared for fricassee, to have as many pieces as possible (Fig. 122C).

When chicken is sold by parts the procedure as described above is the same, except that the breast is left in one piece. This applies to the wings, legs, and back.

Fig. 122. Cutting up a chicken for stewing. (A) Above, the head and feet are first removed. The legs and wings are cut off at the joint. (B) Below, severing the back from the breast

Fig. 122C. Stewing chicken cut into many parts.

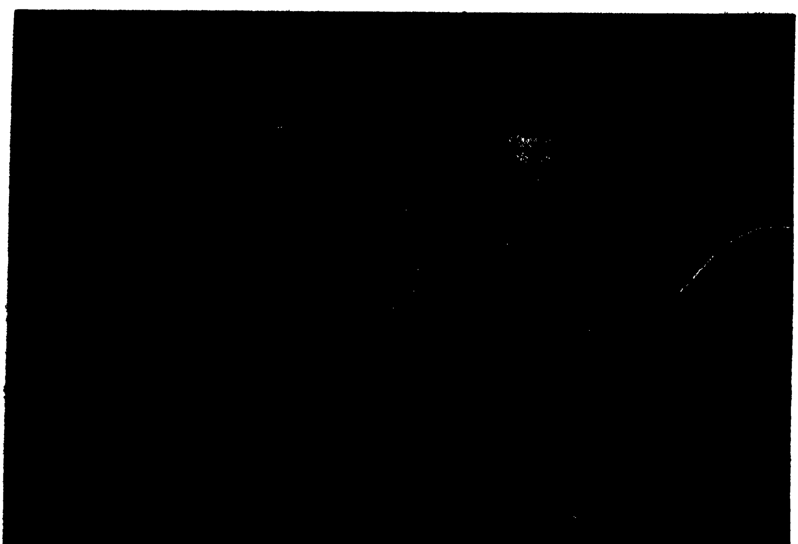
TRUSSING

The trussing of roasting birds makes the carcass more compact and attractive. It also conserves the flavor and juiciness of the birds in roasting. There are several procedures, but a simple one is desirable as most housewives like to wash the bird themselves before they stuff it. One method of trussing is as follows: After removing the tendons (Fig. 123A) and drawing the bird, the neck is cut off at the body, the neck skin is drawn up over the shoulders, and the wing tips are bent under upon the shoulders (Fig. 123C). Place the bird on its back with the rump toward you; hold a string in both hands and pass a loop down under the bird across the shoulders and pull it into the angle made by bending the wings (Fig. 123D). Cross the string on the back (Fig. 123E), bring the ends up, and cross them over the ends of the legs. Draw the legs down tightly (Fig. 123F). Pass the string down the sides of the bird. Turn the bird over and tie the string at the base of the tail (Fig.

Fig. 123A. Trussing a roasting chicken. Removing the tendons, the skin on the shank should be cut lengthwise to expose the tendons.

Fig. 123B. Removing the internal organs. Make a short slit between the vent and the tail. Pass a finger around the intestine then cut around the vent and remove the intestines.

Fig. 123C. Above, bending the wing tips under to hold the neck skin; (D) below, pass the cord across the shoulders and pull it into the angle made by bending the wings.



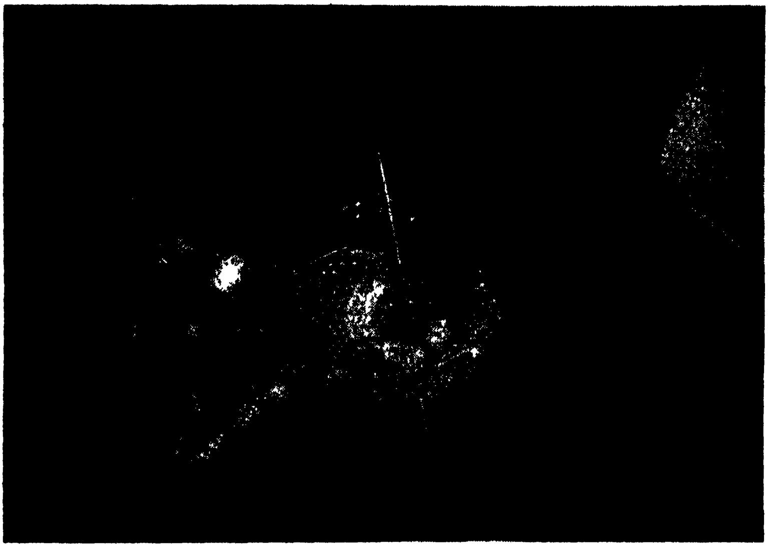


Fig. 123E. Cross the string on the back and bring the ends up and cross them over the ends of the legs; (F) below, draw the legs down tightly, turn bird over, tie at base of tail.

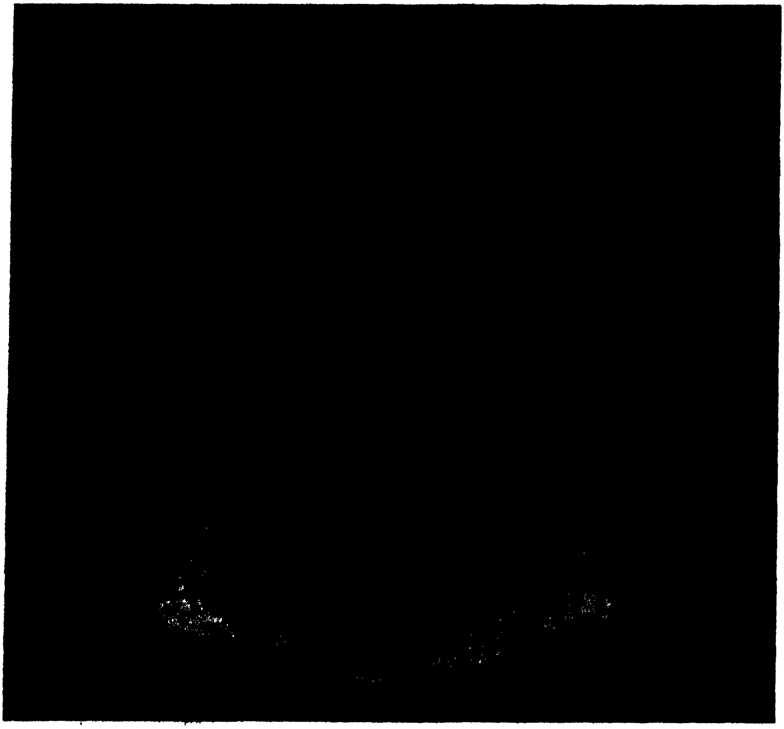


Fig. 123G. Trussed roaster ready to be stuffed.

DEBONED CHICKEN

In the larger markets there is an occasional demand for deboned chicken. This operation removes the flesh from the bones of a chicken all in one piece. It is not difficult to perform, once the technique is learned. Carcasses prepared in this way are suitable for special private occasions or family use.

LOSSES IN DRESSING POULTRY

The losses in dressing poultry vary with the size, age and condition of the birds. The following is a record of losses with different-sized chickens on the Cornell Experimental Farm.

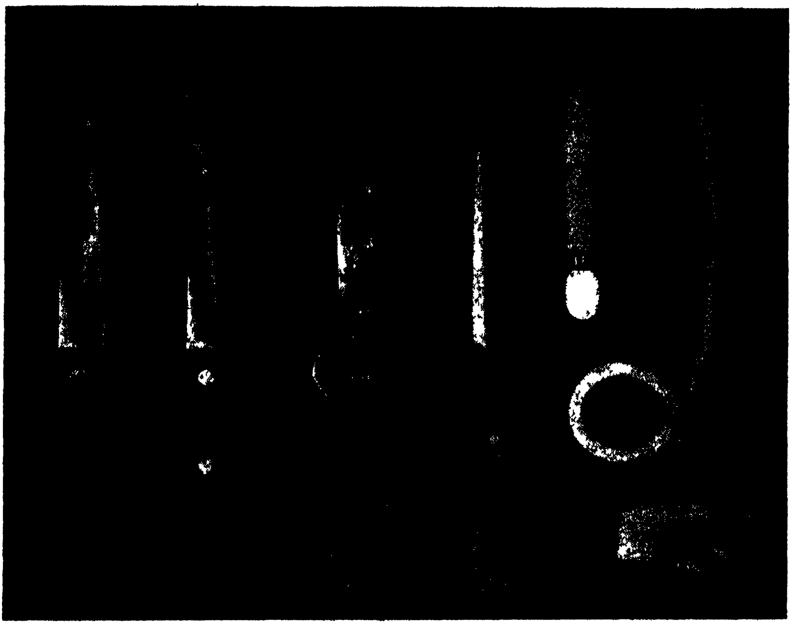


Fig. 124. Tools used in killing and dressing poultry. From left to right, knife for general use, knife for splitting broilers, poultry shears, killing knife, pinner, cord and block for hanging up a chicken.

TABLE XXXIII

LOSSES DUE TO DRESSING AND DRAWING
(Based on Live Weight)

AVE. WT. OF BIRDS ALIVE IN POUNDS	PER CENT LOSS DUE TO DRESSING (BLOOD-AND-FEATHER)	PER CENT LOSS DUE TO DRAWING
Under 3 lbs.	13	27
3 to 4 lbs.	11	25
4 to 5 lbs.	10	22
Over 5 lbs.	9	18

CLASSES OF MARKET POULTRY

Poultry is classed according to its age, weight and sex. The terms used to distinguish the different classes are as follows:

Broilers are young chickens approximately 8 to 12 weeks old, of either sex, of marketable age but not weighing over 2½ pounds each and sufficiently soft-meated to be cooked tender by broiling.

Fryers are young chickens approximately 12 to 16 weeks old, of either sex, weighing over 2½ pounds but not over 3½ pounds each and sufficiently soft-meated to be cooked tender by frying.

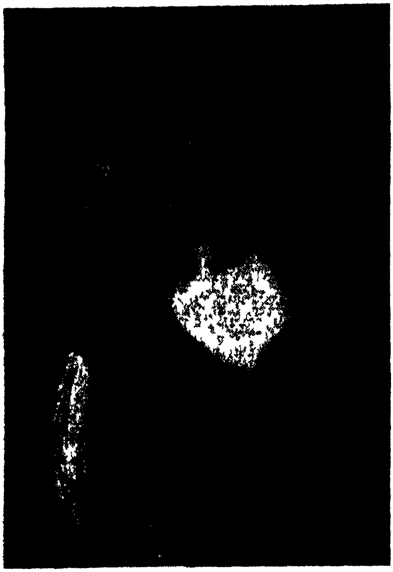


Fig. 125. A handy method of holding a chicken for killing.

Roasters are young chickens approximately 4 to 6 months old, of either sex, weighing over 3½ pounds each and sufficiently soft-meated to be cooked tender by roasting.

Stags are young male chickens of any weight which have matured to the point at which the flesh has begun to toughen. Young males are usually called stags as soon as the spurs begin to develop.

Slips are incompletely caponized young male chickens with the same appearance as stags.

Cocks, or *roosters,* are mature male chickens approximately one year old or older, of any weight.

Fowl are mature female chickens approximately one year old or older, of any weight.

Pullets are young female chickens of any weight, from 4 to 9 months of age.

GRADES OF LIVE POULTRY

The Bureau of Agricultural Economics of the United States Department of Agriculture has suggested the following tentative grades for live poultry:

U. S. Grade A. Vigorous birds, well-fleshed, plump and full-

feathered, with bright red combs and soft, glossy skin. Birds of Grade A must be soft-meated, free from tears, bruises, and deformities. Excess abdominal fat and broken bones are not permitted, and the birds must be free from external evidence of disease. Twenty-four per cent of U. S. Grade B birds and one per cent of U. S. Grade C birds are permitted in the lot.

U. S. Grade B. Fairly well-fleshed birds, fairly well-feathered, free from tears, bruises, and deformities. Broken bones are not permitted and the birds must be free from external evidence of disease. A tolerance of 25 per cent of U. S. Grade C birds is permitted in the lot.

U. S. Grade C. May be poorly feathered birds, poorly fleshed but not emaciated. The carcass may show a few scratches, tears, or bruises. Deformed birds are permitted if fairly well-fleshed. Not more than one broken bone is permitted. Birds must be free from highly infectious disease. No tolerance is permitted for birds that are below that of U. S. Grade C.

Rejects. All cull birds must be graded as Rejects. Rejects include all birds that show evidence of a sick condition, severe injury, extreme emaciation, crop-bound, crippled, or other conditions that render them unfit for food. Birds afflicted with the following diseases are classed as Rejects: (1) roup (catarrhal and diphtheritic); (2) infectious bronchitis; (3) fowl cholera; (4) fowl typhoid; (5) limber neck; (6) tuberculosis; (7) water belly (ascites).

GRADES FOR DRESSED POULTRY

Four tentative U. S. grades for dressed poultry have been set up by the Bureau of Agricultural Economics, United States Department of Agriculture. They are: U. S. Grade AA, U. S. Grade A, U. S. Grade B, and U. S. Grade C. These quality grades are based upon the degree of fleshing, conformation, condition of flesh, bleeding, freedom from dressing or other defects, and freedom from deformities. Fig. 126 shows some of these variations.

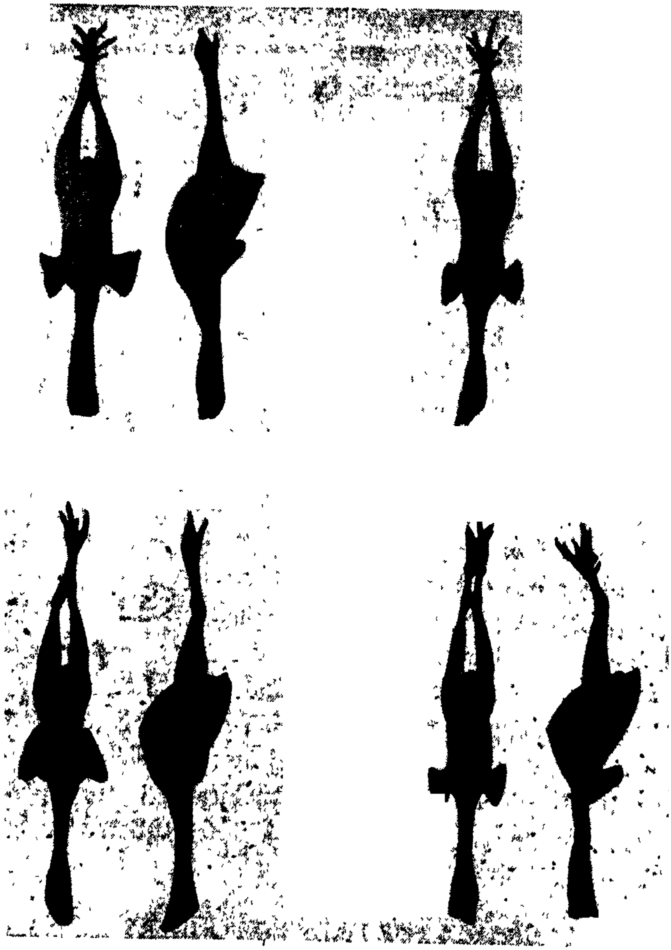


Fig. 126. Tentative U. S. Standards for dressed fowl; upper left, special or grade AA; right, prime or grade A; lower left, choice or grade B; right, commercial or grade C. U. S. D. A.

BROILER-GROWING

Broiler-growing as a special business is comparatively new. Previous to 1920 the broilers marketed were entirely cockerels, a by-product in the production of pullets to replace layers. They were marketed mostly in the summer and fall. The sur-

plus was put in cold storage. A considerable part of the annual output of broilers is still produced in this way.

In recent years there has been an increasing demand for fresh broilers and fryers at all seasons of the year. This has encouraged the development of what is known as the "broiler industry," farms on which broiler-growing is a specialty. Other factors which have contributed to its growth are: a better understanding of the vitamin requirements of growing chickens, improved practices in controlling disease, and better brooding equipment which has made it possible to grow chickens successfully in confinement in winter as well as in summer. With the development of the broiler industry the market trend or demand is for a fryer or a slightly larger chicken than a broiler.

The production of broilers and fryers has become greatly specialized in certain localities, due largely to their favorable location and accessibility to good markets. The most important broiler-producing localities in the United States at present are as follows: The "Del-Mar-Va" area, comprising parts of the states of Delaware, Maryland and Virginia; the New England states; California; parts of Arkansas and Indiana; and Long Island in New York state.

Broiler production is carried on in these areas principally during the fall and winter months, although some broilers are grown throughout the year.

BREEDS USED FOR BROILERS

The breeds used vary according to the location and the market demands. General-purpose breeds such as Barred Plymouth Rocks, Rhode Island Reds, New Hampshires or Red-Rock crosses are preferred in the New York and Boston markets. In the middle western markets, white-feathered breeds such as White Plymouth Rocks, White Wyandottes, or white-feathered crosses are most in demand.

Practically all broiler markets prefer the heavy breeds to White Leghorns, and pay more for them. Not only are Leg-

horns discriminated against as broilers, but they are even less profitable as fryers as it takes them longer to reach a three-pound weight, and they consume more feed than do the heavy breeds.

BROILER-GROWING PRACTICES

Broiler growers follow about the same procedure as commercial poultrymen in raising young stock. Broilers may be grown in colony houses, permanent houses or batteries.

Battery brooding is generally used when the broilers are

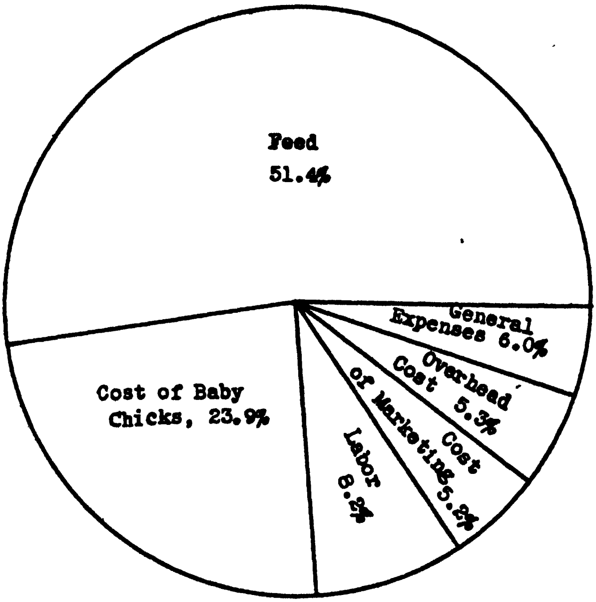


Fig. 127. Percentage distribution of the cost of producing and marketing broilers. Two-year average, 1934–1936. (Maryland Bul. 410.)

dressed and sold locally. It is not so satisfactory when the birds are sold alive, especially with large broilers, because of trouble with breast blisters, poor feathering, and considerable shrinkage when they are shipped. Growers in the broiler-growing areas who have tried batteries have discarded them in favor of floor rearing.

The colony system of brooding is quite commonly used for broiler-growing in all parts of the United States, and is probably most economical when only a few hundred birds are to be

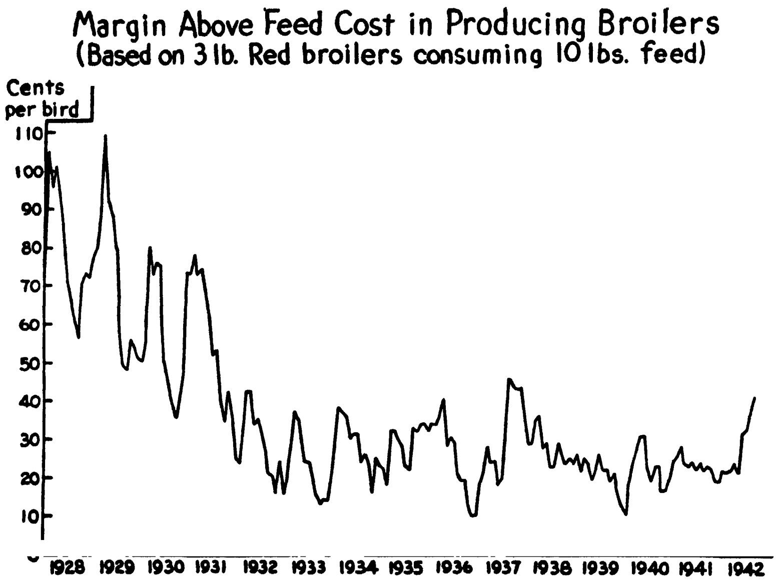


Fig. 128. The margin above feed cost in producing broilers (Based on 3-lb. Red broilers consuming 10 lbs. feed). (Courtesy of A. Van Wagenen, Cornell University.)

grown. It is essential to keep the amount invested in equipment as low as is consistent with good management. This reduces the overhead costs.

Broilers must be grown at low cost to be profitable. Usually the larger flocks, 8,000 or more, are handled at lower costs than smaller ones, 1,000 or less.

Prevention of disease is very important, as a mortality in excess of 10 per cent increases costs materially.

Feed is the largest single item of expense, amounting usually to from 50 to 60 per cent of the total cost. See Fig. 127.[4]

Securing a good price is next in importance to keeping down costs. Selling the birds alive at the farm to dealers has been one

[4] Bulletin 410 University of Maryland.

of the most satisfactory and popular ways of disposing of broilers in the broiler-growing areas. This is not always the most profitable way to market broilers, and any one engaging in this business will do well to canvass all the possibilities.

Surveys show that the margin of profit per bird under the most favorable conditions is usually small. (See Fig. 128.)

PRESERVATION OF POULTRY BY FREEZING

The preservation of fresh poultry and game by the freezing process has increased rapidly in recent years. It has many advantages and possibilities for a poultryman, turkey grower, or duck grower who wishes to avoid seasonal surpluses and to expand sales by having a ready supply of all products throughout the year. When properly frozen and stored, all poultry meat of high quality is substantially as desirable as it was previous to freezing.

Poultry may be kept frozen in lockers in a cold-storage warehouse, in a farm refreezing and storage cabinet, or in a specially constructed refrigerator on the farm.

FROZEN-FOOD LOCKERS

The use of frozen-food lockers by farmers and consumers has greatly increased. A community or commercial frozen-food locker plant consists of a cold-storage warehouse which has a room containing lockers in which a low temperature (0° F.) is maintained. There is considerable variation in the equipment and services of such plants. The meat may be frozen in the lockers, or chilled, sharp-frozen and then placed in the lockers. Whether the meat is frozen in the locker or not depends on the construction of the locker. The more modern locker plants offer a butchering, meat-cutting, packaging and freezing service in connection with the rental of the lockers.

The standard locker contains about 6 cubic feet of space and will accommodate between 150 and 250 pounds of meat if it is carefully packaged and packed.

FREEZING CABINETS

Freezing cabinets are now being offered which are suitable for freezing and storage of foods on the farm. The cabinets have a small freezing compartment which may be maintained as low as —10° F. A fan accelerates freezing. When frozen, the foods are transferred to a storage compartment where a temperature of 0° F. is maintained. The cabinets are movable and can be located in any convenient location on the farm. They vary in size from 10 to 30 cubic feet of storage space. From 30 to 45 pounds of packaged meat can be placed in 1 cubic foot of space.

LARGE REFRIGERATORS

Roadside markets and very large farms often need more freezer storage capacity than is provided in the largest commercially built cabinets. To supply this need, a "walk-in" type of refrigerator may be built on the farm. Such a refrigerator usually consists of two rooms: a cooling room and a low-temperature room. The cooling room is maintained at a temperature of 32° to 34° F. for storing fresh fruits or vegetables or for chilling meats or poultry. The relative humidity in this room should be between 85 and 90 per cent. In cooling meat the right humidity is important. Low humidity increases the loss in weight and flavor, while too high humidity results in molding.

The inner room opens off the cool room and is designed to freeze and store fairly large quantities of products. One or more fans should be used in this room to accelerate freezing.

Since the construction, equipping and operation of such a refrigerator requires technical knowledge in refrigeration, it should not be undertaken without the aid of an expert.

PREPARATION OF POULTRY FOR FREEZING

Frozen foods held in storage dry out quickly unless they are wrapped or packaged. Meat products in particular which

dry out in storage quickly become rancid, take on foreign flavors, become tough, and are dry when cooked. To prevent this, meats are wrapped in special moisture-proof wrapping paper. Latex bags are also used for irregular-shaped products such as poultry. The packaged meat is still further protected by placing it in a stockinette.

Since all fats tend to become rancid in storage after a time and in this condition are unpalatable to the majority of persons, all packages should be labeled, dated, and consumed before this condition is likely to appear. Poultry can be stored safely for 12 months if a temperature of 0° F. or lower is maintained.

The New York State Agricultural Experiment Station[5] summarizes the procedure for preparing and freezing different kinds of poultry as follows:

Dressing poultry for roasters, broilers, or for fricassee:

1. Slaughter, pick, remove all pin feathers.
2. Cool thoroughly overnight.
3. Draw and wash birds thoroughly with cold water.
   - A. Roasters:
     1. Wrap giblets and neck in moisture-vapor-proof paper, insert in cavity of bird.
     2. Wrap birds in recommended paper.
     3. Place wrapped bird in stockinette.
   - B. Broilers:
     1. Place halved bird together with two pieces of paper between halves, then wrap.
     2. Place in stockinette.
   - C. Fricassee chickens:
     1. Cut up or disjoint bird.
     2. Wrap in suggested paper; place in stockinette.

To freeze all birds, place in the freezer at 0° F. or below before an air blast, and, when frozen, store at 0° F. or below.

[5] Bulletin 690, p. 36.

SMOKED POULTRY MEAT

In recent years there has been considerable interest in smoked cured turkey and poultry meat. This is prepared by pickling in brine and smoking like pork hams.

Two methods are available for smoke-flavoring and curing poultry meat. One consists of a process in a brine in which the salt has been smoked or a liquid carrying this flavor is added; while in the other the meat is cured in a sugar-and-salt brine and then smoked, preferably with hardwood.

Salt, sugar and saltpeter are the essential ingredients for the brine. Other ingredients are often suggested but are of doubtful value.

The curing mixture recommended by the United States Department of Agriculture consists of 6 pounds of salt, 3 pounds of sugar, and 3 ounces of saltpeter, dissolved in 4½ gallons of water. Fifty pounds of carcasses well packed in a 25-gallon crock or barrel will require about two times the quantity of brine indicated in the formula. Since this is only a curing solution, the meat must be smoked for the smoke flavor.

Commercial mixtures which include the smoked salt may be purchased. Smoking is not necessary with such brine solutions.

The process may be summarized as follows: Kill, dress and draw the birds. Pack the carcasses closely in a clean odorless crock or a hardwood barrel, and weight them to prevent them from floating when the solution is added. Be sure the carcasses are well covered with the solution. Keep in a room where the temperature is about 40° F.

When turkeys were processed at Cornell University, injections of the curing solution in the thick meat and around the joints just previous to soaking in the brine hastened the curing process and reduced the length of the curing period.

The injections were made with a glass syringe equipped with a number-twelve needle. About 10 cubic centimeters of the solution were injected into each bird.

Seven days of curing was found to be the most satisfactory. At the end of this time, the carcasses were removed from the brine, washed carefully, and hung in a cold room to drain and dry for from 12 to 24 hours before they were cooked.

It is probably best to use smoke-cured birds soon after processing. However, wrapped in cellophane and stockinette bags, carcasses may be kept for several months under conditions which prevent molding.

Broilers were cured for 3 days in a smoke-brine solution at Cornell University and were quite satisfactory when consumed within a few days.

When fowl and turkeys are to be smoked, they are first cured in the brine solution, dried for about a day, and smoked at a temperature of about 110° F.; 135° or 140° F., will give a more desirable color. The length of the smoking period will depend on the intensity of smoke flavor desired. At Cornell University a well-flavored product of medium brown color was obtained when the smoking period was 8 or 10 hours a day for 3 days at a temperature of about 110° F.

CANNING POULTRY MEAT

Poultry meat is canned on many farms for use in the home or for sale. Surplus cockerels or non-laying hens are generally used. Fat birds one year old or older have the best flavor when canned. The procedure is as follows:

Kill, pick and singe the chickens and thoroughly cool the carcasses before canning; six hours is usually necessary. Cut up the dressed chicken, as for cooking. Remove the intestines, lungs and kidneys. Clean the skin thoroughly with a brush and lukewarm suds. Rinse thoroughly and cut into pieces that will easily go into the jars, add 1½ teaspoonfuls of salt to each quart. Fill the jars to within ¾ inch of the top, but add no water. Use new rubbers. Place the covers in place and partly seal.

When a pressure cooker is used, process for 80 minutes at

15 pounds pressure. With the boiling-water-bath method, put the jars in the canner, in about two or three inches of cold water. Cook the meat for 4 hours, counting from the time the water commences to boil. Remove the jars and seal.

One quart jar is required for each dressed chicken weighing from 3½ to 4 pounds.

CAPONS AND CAPONIZING

A capon is a male chicken which has had its reproductive organs removed. A capon bears the same relation to a cockerel among chickens as a steer does to a bull among cattle or a gelding to a stallion among horses.

A capon seldom crows or fights. He takes on feminine characteristics and has been known to mother chickens like a hen. The comb and wattles lose their bright red color and fail to develop as fast as the remainder of the body. The saddle- and hackle-feathers grow long. Capons are more docile, less nervous and excitable, and much easier to keep within bounds. As the result of a more peaceful disposition, there is a tendency to grow larger and to produce a finer quality of flesh than do cockerels of the same age.

The best age at which to caponize is when the sexual organs first begin to develop. This point is best determined when the face and comb begin to redden. The testicles at this time should be about as large as a kernel of wheat. Usually cockerels weighing from ¾ to 2½ pounds, or six to twelve weeks of age, depending on the breed and the rate of maturity, are about the proper age and size. If the bird is too old when caponized, there is greater danger of its bleeding to death, not only because the blood-vessels leading to the testicles are larger and carry more blood, but the arteries located near them, being larger, are more likely to be ruptured.

The birds should be kept in a clean coop or pen without food or water for twenty-four to thirty-six hours before being operated upon. Starving reduces the size of the intestines and

makes the operation easier, while withholding water tends to thicken the blood and lessen bleeding.

Several types of holding devices, caponizing boards and tools are sold. Their selection is largely a matter of training and choice. A simple outfit is shown in Fig. 129.

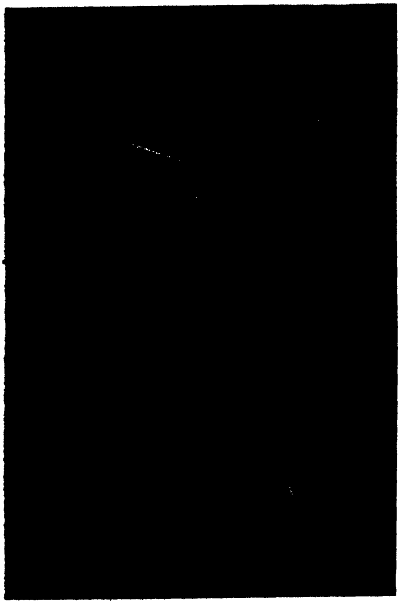


Fig. 129. Tools and equipment for caponizing. A, *hook;* B, *knife;* C, *remover;* D, *spreader;* E, *weights for holding the bird in position;* F, *glass containing solution for disinfecting instruments.*

The caponizing should be done when there is good light, preferably out-of-doors in a protected place, on a bright sunshiny day. Near at hand, a table should be provided for the tools and a small pan or glass containing a 5-per-cent solution of carbolic acid and water for disinfecting the instruments.

A cockerel is fastened to the barrel as shown in Fig. 130. The manner of performing the operation is shown in Figs. 130, 131.

Caponized birds should be placed in a pen by themselves for a few days until they have a chance to recover from the operation. Afterward they may run with the remainder of the flock. The usual ration of mash and grain is fed.

Sometimes a few of the birds will bloat during the first week. Such a condition is not serious if attended to promptly. Each affected bird should be caught, the skin pricked with a coarse needle or a sharp knife, and the air allowed to escape.

Deaths due to bleeding may run to 5 per cent even when the operation is performed by an expert. With beginners, the losses

may be even greater. Birds that die during the operation by bleeding may be used for food.

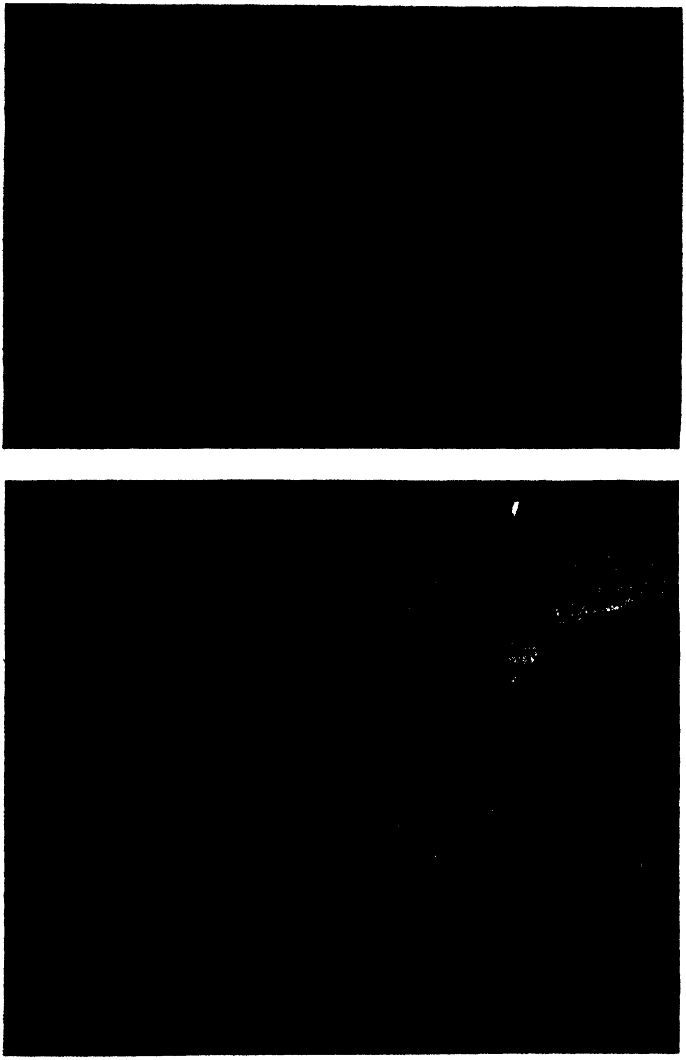


Fig. 130. Above, the first step in caponizing. The bird in position; note the feathers plucked from the sides. Below, making the cut between the last two rib-bones.

Often persons just learning to caponize will leave a small part of the testicle in the bird. This will grow and the bird will be neither a cockerel nor a capon. Such a bird is called a

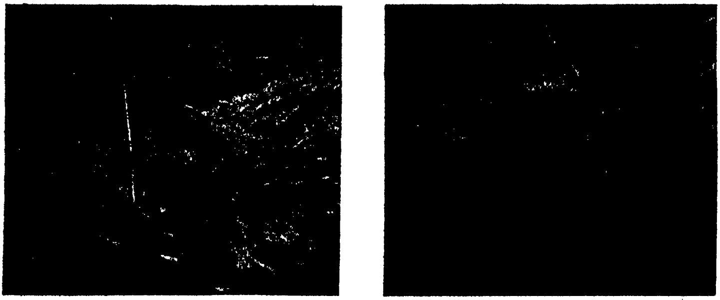


Fig. 131. Left, the spreader in position with the tissue ready to be torn with the hook. Right, removing the testicles.

"slip," and, although it has the appearance of a cockerel, it will seldom be able to reproduce. The number of "slips" varies from a large proportion with beginners to about 2 or 3 per cent with experts.

Caponizing is a comparatively simple operation but requires practice. Beginners should learn its technique first by watching an expert and afterward by working on a dead bird. Capons are usually kept from nine to twelve months before marketing, to give them time to reach their maximum size. As a general rule, cockerels will gain in weight faster up to about five or six months than capons. After that period the capons take on flesh more rapidly.

The best time of year to dispose of capons is usually from December to April, although this may vary according to the market. The feeding and care of capons just before marketing is similar to that already described for other fowls.

Most markets pay more for capons weighing over 9 pounds, but different markets vary as to the size desired. The demands of the market should be considered in supplying the trade.

For heavy capons Black Jersey Giants, Light Brahmas and

Langshans should be chosen. The American breeds, such as the Plymouth Rock, Rhode Island Red and Wyandotte, produce a medium-weight capon weighing about 7 to 10 pounds. Leghorns are too small for good capons. As usual the market prefers a yellow-skinned bird.

Very little accurate information in regard to the profits and losses in growing capons is available. Generally speaking, capons are most profitable as a side line to a regular poultry business, or when it is necessary to keep meat birds for long periods to supply a special private trade.

Fig. 132. The operation completed. It is not necessary to sew up the opening.

The available experimental data together with the experiences and opinions of those who have kept capons seems to be that the same house room devoted to laying stock will return greater profits. Feeding, the cost of the buildings, marketing and labor costs reduce the net profits unless a very good price is received. Feed appears to be the greatest cost and mounts rapidly as the birds grow older. According to Botsford,[6] "Capons of American varieties will gain from six to eight pounds in about as many months after caponizing and it will require eight to ten pounds of grain and mash to produce a pound of gain." Ordinarily, therefore, it is likely to be more profitable to market the surplus males as broilers. Before going into the business on a large scale, it is advisable to keep books and find out how much real profit can be made.

[6] "Capon Production," N. Y. State Exp. Sta., Cornell Univ. Bull. 143.

XVI. Culling and Selecting Poultry by External Characters

THE detection and elimination of the low-producing hens in any flock is an important problem. Many times the success or failure of a poultry enterprise depends on this. Likewise, the selection of the best layers for breeders is valuable, as it is by the continual selection of the type of bird desired that the average production of the whole flock is improved. There are hens in every flock which, under favorable conditions of management and breeding, fail to produce profitably. This has been demonstrated time and time again at egg-laying contests, government experimental stations and on private farms.

The more careless the breeding and management of the flock, the higher the percentage of culls is likely to be. Even in a well-bred flock some birds always have to be taken out each year in order to maintain a high plane of efficiency.

Trap-nesting has made it possible to study the characteristics of individual laying hens day by day and, as a result, classify them accurately according to their production at certain seasons of the year. It is customary to classify hens as high, medium and low producers according to the number of eggs laid during the period of a year. Sorting out hens of low production is called "culling," while the choosing of the best layers is referred to as "selection." Of course, in the broad sense, "culling" means the elimination of the undesirable chicks, pullets, hens and males, but in recent years poultry-keepers have come to think of "culling" as more particularly applied to the sorting of hens to determine their laying qualities. It is always good management to cull out weak inferior stock at any time of the year.

The culling and selecting of hens is not difficult to learn, for thousands of persons all over the country have demonstrated that with a little practice and judgment they are able to detect better than 90 per cent of the low producers in their flocks. Of course, the details must be explained carefully at the beginning.

The very good layers and the very poor ones are easy to identify, especially if the flock has been well cared for, but the medium producers are often a puzzle and require considerable experience. Since the medium producers are neither poor nor very good layers, it is not serious if an error is made one way or the other in classifying them. Likewise, considerable experience is also required in judging the length of time a hen has been laying, the intensity of the lay, and the vacations or non-producing periods. Similarly, good judgment and extensive experience are needed in culling a flock which has been mismanaged or upset by an epidemic of sickness. After all, the essential in culling and selecting is to find the very poor and the very best layers. This ordinarily is comparatively easy, if one has a little practice and is a keen observer.

WHEN TO CULL

The best time to cull hens is in the months of July, August, and September. After the peak of production in April and May, a gradual decline sets in which reaches its lowest point late in the fall. The best hens are exceptional, in that they lay well during the summer and early autumn after the average hen has stopped. They seem to have the tendency to lay so well bred in them that, even if conditions are unfavorable, they lay on just the same. The poor layers, on the other hand, stop soon after the spring rush, and remain in a non-laying condition until toward spring of the next year. Therefore, to save feed and housing space, it is best to start inspecting the flock the last of June, or just as soon as a few hens show signs of stopping and there is a noticeable drop in production. Inspections

should be made regularly every two weeks until September 15th. After that date and until December 1st, the breeders should be selected for the following season. A good breeder must not only show that she has laid long and persistently, but she must have the proper color of plumage and the characteristic shape of the breed.

When only one culling is made in the season, it is best to wait at least until September 1st so that a larger percentage of birds will be included in those culled. In most flocks, it is advisable to take out from one-third to two-thirds of the birds each year. Close culling limits the number of very old hens kept over, and also helps to keep the average annual production of the whole flock higher.

HOW TO CULL

When the time comes to cull the flock, plans must be made for catching the hens (Figs. 133A, 133B, 133C, 134, 135). If they run at large, they must be shut in their houses the night before. The method of catching must be such that it will not frighten the birds too much, for undue fright is likely to check the production of some hens.

One very good way of catching hens is to build a catching crate with a sliding end and an opening on the top (Fig. 136). The end of this crate can be placed against the runway hole on the outside of the building, or in an opening between pens on the inside. Grain is scattered on the floor of the crate and a few hens quickly driven into it and the sliding door closed. Each hen is then easily caught and removed through the sliding door at the top. Those to be retained are immediately released into the yard outside, or an adjoining pen, while the rejected ones are placed in a nearby shipping crate for future disposal. Sometimes after a part of the flock has been caught, the remaining hens become suspicious and there is difficulty in driving them into the coop. In this case, it is usually advisable to attach the end of a roll of wire about 20 feet long

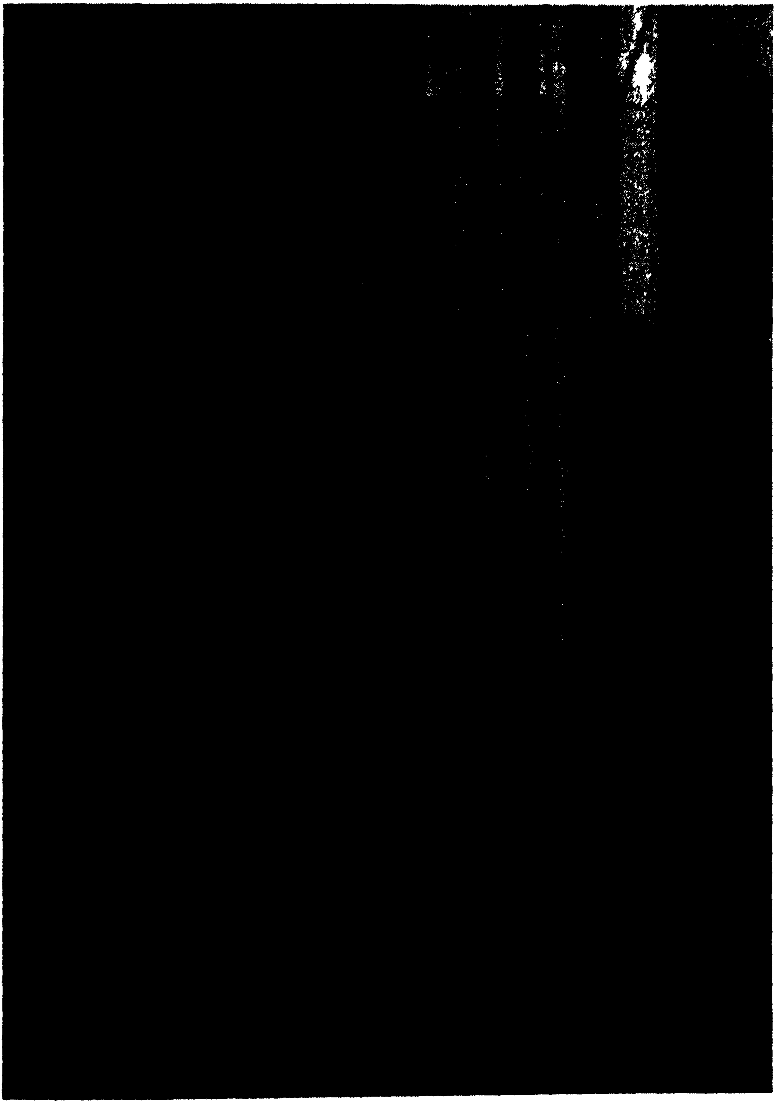


Fig. 133A. Using a short roll of wire to catch hens. The end of the roll of wire is attached to the side wall with nails. This method of catching hens is explained further in Fig. 133B and 133C on pages 352 and 353.

to the side wall of the house, about 2 feet from the runway, and unroll it toward the center of the room. This acts as a barrier and aids in driving the hens. A few hens can then be driven

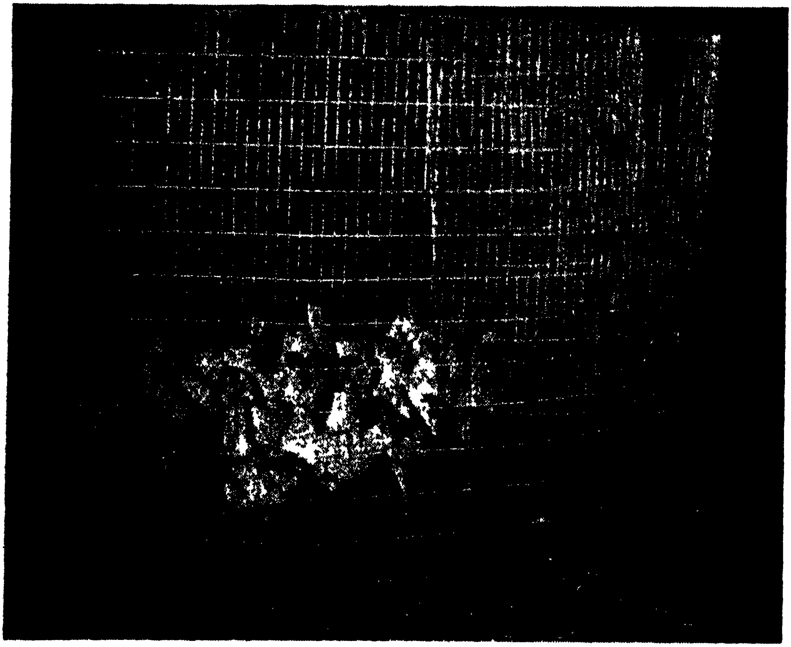


Fig. 133B. The wire is unrolled toward the center of the room encircling a group of birds.

toward the hole, and the roll of wire brought around to the side wall and rolled up, so that the hens are forced into the crate. When a crate is not available, the roll of wire may be used alone. When this is done, one person remains on the inside to catch and hand the birds to the inspector on the outside.

In order to save frightening their fowls, some poultry-keepers inspect them at night. A flash-light is used to detect the hens out of laying condition. These are examined again the next morning by daylight. This plan does not upset the laying of the flock very much and is rapid, but does not permit as accurate culling as when the work is done in the day time. Night

culling, however, is probably a better method than daylight for the poultryman who does not handle his birds carefully and quietly.

Fig. 133C. One man steps inside the enclosure fastening the roll to the wall behind him. Birds are passed out to a second man.

The culler, to be real expert, must be able to distinguish three factors about the birds handled; in the first place, he should determine whether they are laying or not; second, he should try to estimate the length of the laying period or the persistency of production, and lastly, he should try to determine what is the rate of production or intensity.

It is not advisable or wise to discard any hen as long as she is laying. Doubtful birds may be retained and culled later.

Before passing judgment, all the characters of production should be used in examining each bird in a flock. When

there is a question about the laying condition of a bird, it should be given the benefit of the doubt. In selecting, however, the reverse of this rule should hold, since in the latter case,

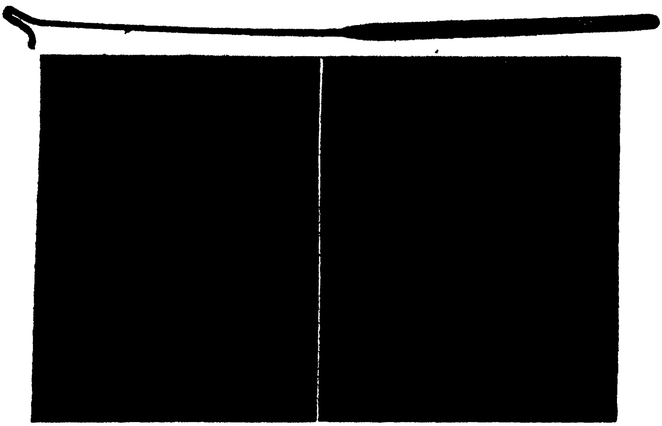


Fig. 134. Above, a catching hook. Below, a fish landing net for catching individual birds.

Fig. 135. Using the catching hook.

only those that are sure to be good are desired. Fewer mistakes are made by following such a policy.

Fig. 136. Crate for catching hens and moving chickens.

JUDGING A HEN FOR PRESENT PRODUCTION (Figs. 137, 138)

Present production or laying condition is best determined by inspecting the physical condition of the comb, wattles, earlobes, pelvic bones, sternal processes and vent.

The comb, wattles and earlobes of a hen are known as the secondary sexual characters because their physical condition alters with every change of the ovary. In other words, their appearance reflects the activity or inactivity of the organs of reproduction. When a hen is in heavy production, the comb, wattles and earlobes are large and full, but just as soon as production falls off and ceases, they contract and change color. These changes are most easily seen in breeds like the Minorcas, Leghorns, Anconas and Campines which have good-sized single combs, large wattles and white earlobes.

The comb is an excellent indication of the laying condition of the hen, for it not only expands and contracts quickly, but

also changes color and condition promptly. The laying hen's comb is full, smooth, stiff, shiny and waxy to the touch. It has a rich bright red appearance. When production ceases the

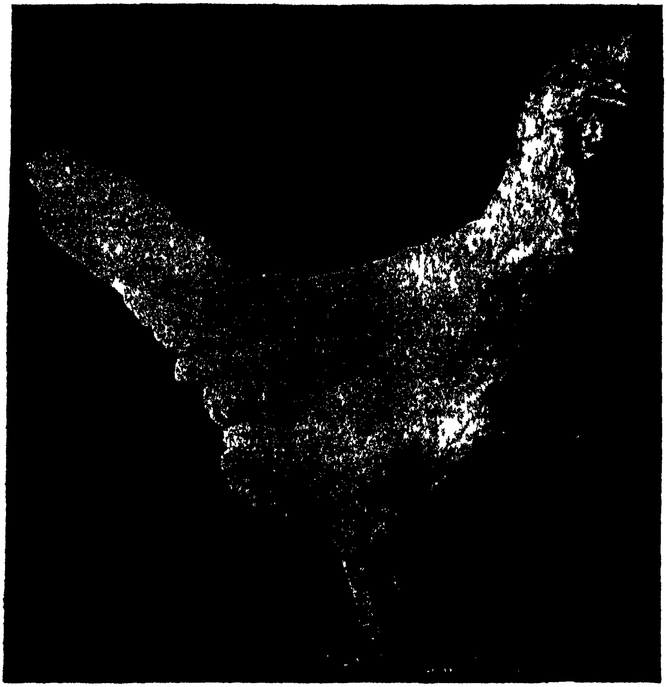


Fig. 137. A typical high producer. Note the large full red comb, the bright intelligent eye, old ragged plumage, deep rectangular body.

comb immediately becomes limp and then slightly dry and rough. It is covered with a white scale or dandruff which gives it a pale red color. As a bird approaches the laying condition, the comb begins to expand and there is a more active flow of blood which makes it feel warmer than common. Usually a hen in production, if she has not been unduly disturbed or frightened, has a slightly cool comb. The expansion and color of the comb furnish one of the best means of telling when pullets are approaching their sexual maturity and are about ready to lay.

Sometimes a hen may have a bright red full comb and not be a layer, due to some imperfection of the internal organs. Egg-yolks are formed but reabsorbed or there may be a tumor on the ovary which prevents the normal development of the yolks. Sometimes the pelvic bones of such hens are very close together, rigid and covered with fat, the vent is small, puckered and yellow and the bird carries considerable color in all parts of the body. Thus the comb indicates that the bird is laying but the body characters contradict it. Such conflicting evidence should be viewed with suspicion.

Fig. 138. A typical low producer. Note the small dried-up comb, dull sunken eye, new plumage, shallow body.

The pelvic bones are easily found just above and on each side of the vent of the hen. The spread of these bones determines the present laying condition of the bird. A hen which has a span between the ends of the pelvic bones of two or more fingers is usually considered laying, while one with only one finger span or possibly two, is considered in a non-laying condition. The pelvic bones of the laying hen are thin and pliable, especially if the bird is a very high producer. As production decreases and comes to a standstill, large amounts of fat may accumulate around the ends of these bones making them thick and stiff.

The pelvic-bone test is one of the easiest and simplest ways of telling when a hen is laying, but is not an infallible guide in determining how many eggs a hen will lay, or has laid.

The lateral processes are two little rib-bones on either side of the breast-bone which have one end flexible and unattached. They form the floor of the body cavity and during heavy production are forced down into a very prominent position by the increased weight of the internal organs. These bones are pliable while a hen is laying, but when production

Fig. 139. Left, hen in non-laying condition. Right, body and vent of hen in laying condition. (Cornell University.)

ceases they become rigid and are sometimes difficult to locate because of the fatty flesh surrounding them.

The vent of a laying hen is large, moist and dilated and rather oval in shape (Fig. 139). The surrounding flesh is soft and pliable which gives it a loose flabby appearance. The non-layer has a hard, round, small puckered vent (Fig. 139).

With the laying hen the abdomen is soft, pliable and enlarged, because the developing egg-yolks and increased consumption of food during production causes the organs of digestion and reproduction to occupy more space. All this means

a stretching and spreading of the body tissues to meet the demands of nature.

When a hen stops laying, less space is needed for the organs of digestion and reproduction and the abdomen contracts. The pelvic bones draw closer together; the rear of the keel regains its normal position nearer the pelvic bones, and the skin becomes thicker and more tightly drawn.

PERSISTENCY IN LAYING

Having decided whether the hen is laying or not by the changes in the physical condition of the comb, wattles, body and vent, the next step is to verify the decision and try to determine the persistency of production by the going and coming of the yellow pigment throughout the body, and the molt.

Changes in pigmentation. Scientists have discovered that a certain yellow pigment material, called xanthophyll, is taken from the food which a hen eats and deposited by the blood in the fat and skin of the body. It is this coloring matter which gives the so-called yellow-skinned breeds their yellow shanks, beak, eye-ring and skin. This same coloring material appears in the yolk of the egg. When a hen is not laying, the color accumulates in the fat and skin of the body, but when laying begins all the coloring material seems to be diverted to the egg-yolk and the surplus of color is slowly lost as production continues. The color comes and goes the most rapidly where the blood circulation is the greatest, but is modified somewhat by the kind of food supply and the amount of fat stored in the body.

All color changes should be observed by daylight, as it is impossible to distinguish shades of yellow by artificial light.

With the exception of the shank coloring, the presence or lack of pigmentation in the different parts of the hen's body indicates the amount of production in the immediate past.

Color changes are of the greatest importance during the early part of the culling season, but it must be remembered that they are more easily affected by feeding conditions than any other character that has to do with culling.

Probably due to circulation, the skin around the vent is first to lose or regain its color, then the eye-ring, the earlobes, beak and lastly the shanks. The rapid changes in and around the vent are due to the expanding of the body tissue and the stretching of the skin, which seems to increase activity of the blood flow in these parts. The yellow color begins to fade sometimes just before production begins and disappears entirely after a few eggs are laid. As production continues the skin around the vent becomes whiter and whiter until, after long heavy production, it is a bluish-white.

The edge of the eyelid, or eye-ring, is the next to fade. Like the vent, the yellow color disappears soon after laying starts, but not quite as quickly as in the vent.

Some yellow-skinned breeds like the Leghorn and Anconas have yellowish-white earlobes. On all such breeds this section of the body changes color in just about the same time that the eye-rings do.

The beak fades out more slowly and is not entirely white until production has been in progress from four to six weeks. The changes of color in the beak are interesting inasmuch as they tell more about the way a hen lays than other color changes about the body. The yellow disappears first at the base of the beak and then the fading gradually works its way down to the tip. As soon as a hen stops laying, the color begins to return, first at the base of the beak and then out to the tip in the same order it disappeared. If a hen, after being in production for a long time, takes a short vacation for any reason, this will be indicated by a yellow band around the middle of the beak. A hen that has produced regularly for some time and has stopped laying for a few days will show a band of yellow around the base of the beak, while the outer sec-

tion including the tip will be white. A pullet or hen that has been laying for two or three weeks will show a band of white at the base of the beak and the tip section yellow. A beak showing yellow and white mottling or stripes around it indicates that the bird is an irregular layer, or is naturally a slow or poor producer. Broodiness or improper management may be responsible for this condition.

The Rhode Island Reds and Barred Plymouth Rocks and some other breeds have beaks that are nearly all black, or dark brown, or horn color. This condition makes it more difficult to determine the changes in pigmentation. When such conditions prevail, variations in color can best be determined by looking along the edge of the mandibles, or more particularly, on the under side of the lower one.

The shanks lose color slowly and for this reason are the best guide of all the color changes in determining the length of time a hen has been in or out of laying. It usually takes from five to eight months of laying for the shanks to fade out entirely. The rate of bleaching depends on the breed, the food and the vigor of the stock. Lack of vitality, absence of feed rich in yellow pigment material (such as leafy green food and yellow corn), close confinement indoors or on small bare yards, will increase the rapidity of the bleaching. Such breeds as the Leghorn and Anconas lose their color more rapidly than the larger breeds like the Plymouth Rocks and Rhode Island Reds or Brahmas. Often there is a wide variation in the tint of yellow color in the shanks of birds of the same breed and variety. Some birds will have a pale lemon colored shank while others will have more of an orange-yellow. It is generally considered that this variation in color is due to a difference in vitality and breeding. Usually the deeper the color, the more vitality the bird possesses. The deeper shades of yellow require more time to fade out, consequently it is important when examining the color changes in the shanks to try to determine the original color. Some important evidence can

be obtained by noticing how the different parts of the shank and foot has retained or lost color. The first part of the shank to fade is the bottoms of the feet. Then comes the front of the shank, the back of the shank, the top of the toes, and lastly, the front of the ankle joint and hock joint. It often happens that breeds with orange-yellow shanks sometimes never lose all the color in every section.

The shape of the shanks is affected along with the color changes. The heavy-laying bird loses fat and flesh in the shanks as well as throughout the body. This leaves them more triangular. On the inside of the shank of a bird that has produced for some time, the large blood-vessel which passes down toward the toes is easily seen because of the deep blue of the blood contrasting with the white condition of the shank. The more easily this blood-vessel is distinguished, the more it adds to the certainty that the hen has been laying for a long time and probably at a high rate.

In considering color changes it must be remembered that they are tied up with the fat of the hen's body. The more fat there is the stronger the color is likely to be and the slower it will fade out. This is probably due to the fact that the presence of fat is an indication that the bird is physically fit and has reserve strength. The continuous laying of large numbers of eggs, being the act of reproduction, is very exhausting and is likely to deplete the body rapidly, unless great care is exercised in feeding and general management.

Sick hens demonstrate this point very well. They have little fat in the body and show a bleached-out or white condition in all parts. The bleached condition in this case is not the result of heavy laying, but means that they are physically unfit. An observing person will not confuse such hens with producing birds, for ailing hens have a general mussy condition of the feathers and a purple withered comb.

When hens stop laying for any reason, the yellow color immediately begins to appear. It comes back first to those parts

of the body where it first disappeared. The vent, eye-ring, ear-lobe and beak take about the same time to recover their yellow color as they did to lose it. The shanks are the exception, for they regain it much more rapidly than they lose it. Sometimes extra fine laying hens take such a short period of rest between seasons of production that they do not have time to recover the shank color.

Breeds like the Minorcas, Campines, Orpingtons, and Sussex and others which naturally have a white skin, do not show the changes in pigmentation. No attention is paid to this phase of culling when these breeds are examined.

The molt (Figs. 140, 141). Evidence of the persistency of production is seen in the way in which hens molt. The best layers usually molt late in the fall just as cold weather is approaching and make a quick job of it. Hens that stop laying in the summer when conditions are favorable and molt slowly for several months are usually poor layers. This strong tendency to lay, or not to lay, is a matter of inheritance, nevertheless it gives the person who is culling or selecting a valuable clue as to the laying qualities of the birds.

It is not difficult to distinguish the difference between hens that are molting and those that are not. The plumage of the molter is clean, neat and trim, for it is for the most part new and has not been soiled, worn or broken by long use.

Most persons consider a hen to be molting regardless of whether the feathers are falling out or growing in. However, in the strict sense of the term, a hen is only molting when she is shedding feathers. It is important to keep this fine distinction in mind when examining hens for molt, otherwise it may be rather confusing and difficult to place some birds.

As a rule, hens stop laying before they start to molt unless they are exceptionally good layers. This is particularly true of breeds like the Leghorns. The heavier breeds such as the Plymouth Rocks and others are more inclined to lay and molt at the same time. Some individual hens are spasmodic in the

way they shed their body-feathers; *i.e.*, they may stop laying for some reason, molt for a short time, stop shedding feathers, and return to production while the new feathers are growing in. Under normal conditions of handling, such birds are not the best layers. The feathers on the neck are the first to drop out, then those on the back and fluff fall, and are followed by those in the wing and tail. Molting in the neck usually only slows up production, but the shedding of body-feathers gen-

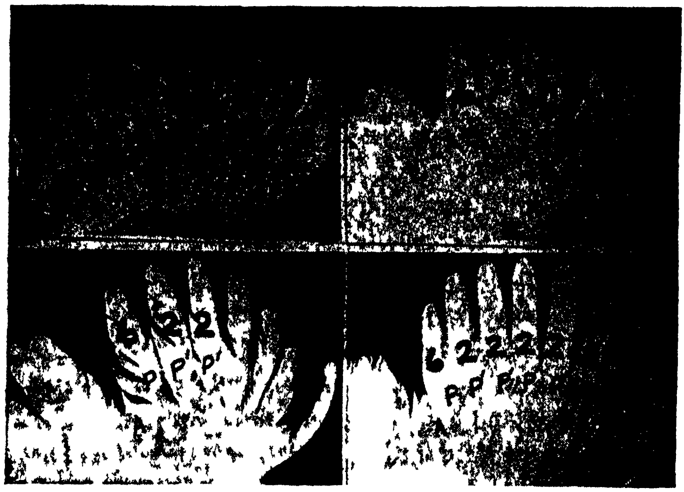


Fig 140. The molt, A, axial feather, P, primary feather Above, left, a six-week molt (primary feather next to axial feather renewed), right, an eight-week molt (two feathers completely renewed). Below, left, a ten-week molt (three feathers completely renewed); right, a twenty-four-week molt (ten feathers completely renewed). (Courtesy of Cornell University)

erally means a cessation of production. Irregular molting may be the result of poor management, or an indication that the bird is not bred to lay.

When the molt becomes serious enough to affect the feathers of the body, such as the back and fluff, and production ceases, the main quills in the primary, or outer section of the wing, begin to drop out. The first feather to fall is located next

to a short quill in the center of the wing called the axial feather. The axial feather is opposite the main joint in the wing and separates the outer section from those nearer the body known as the secondaries. In most breeds and varieties there are ten quills in the primary section, counting from the outside toward the axial feather, but not including it. In some of the heavier breeds there are eleven quills.

Hens vary in the rapidity which they shed these quills according to their ability to lay. The low producers drop a quill at a time, at intervals of about two weeks, while the better layers may shed two, three or five feathers at a time in the same period. It is possible, therefore, for the late molter to molt completely in a few weeks, while the slow molter may take six months.

Fig. 141. Characteristic appearance of late molters growing feathers rapidly. (Courtesy of Cornell University.)

When two or more feathers fall out at the same time, they are considered as one feather in allowing for the new ones to grow in.

The rule generally followed in determining the period of molt by the quills in the wing is to allow six weeks for the first feather to grow in, and two weeks for each succeeding full-grown new feather. The partly grown feathers are not counted.

If, for example, it is desired to determine the length of time a bird has been out of production when the first quill is not full grown, the fraction of the full length of the quill is first estimated. The number of weeks (six weeks) required to grow a completely new feather is then divided by this frac-

tion. For example, if the feather is two-thirds grown, it means that it has been growing for four weeks ($6 \div 2/3$). The approximate date when the hen stopped laying can then be decided by counting back four weeks from the date on which the examination is made.[1]

Again, if the first two feathers are new and full grown, the bird has been molting eight weeks; if there are three completely new feathers, ten weeks; four new feathers, twelve weeks and so on.

A hen that is molting regularly will have growing feathers of all lengths from those just starting to those that are full grown. An intermittent molter will show full-grown new feathers or some nearly so with others perhaps just beginning to grow. This denotes a period when the bird did not molt or went back to laying before resting again. This is known as a vacation molt. If the vacation has occurred recently, it can be confirmed by the appearance of the beak. The very best layers molt and lay at the same time.

The variations in the wing molt are interesting when properly interpreted for they furnish a reliable guide as to the character of the hen.

VARIATIONS IN WING-MOLT[2]

Some hens that take a vacation molt have an interesting variation in the order in which they replace the primary wing-feathers. Instead of repeating the molt of feathers replaced earlier in the summer, they resume the molt at the point where the last feather was dropped. After completing the molt of the remainder of the old, or outermost primaries, they then replace the first, or innermost feathers molted earlier in the sea-

[1] Recent observations at Cornell Univ. indicate a variation in the growth of the quill. About 60 per cent of the length of the feather is grown the first three weeks and 40 per cent the last three weeks.

[2] Adapted from Bull. 503, Cornell Univ., entitled, "The Molting Factor in Judging Fowls for Egg Production," by D. R. Marble.

son. Not all hens follow this peculiar variation of molt, but it must be kept in mind when observing the wing.

The greatest difficulty connected with this variation is to tell whether the bird is a good producer that has had a vacation perhaps due to poor management, or whether she is naturally a poor producer with a tendency to lay intermittently.

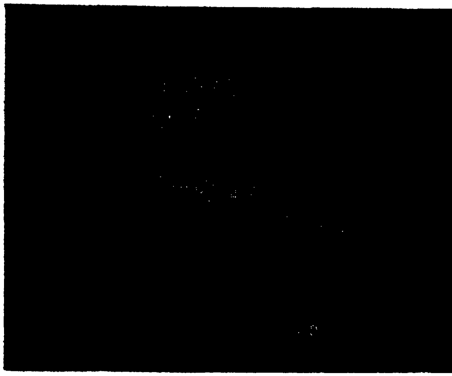


Fig. 142. New feathers in the primaries as distinguished from the old feathers. (Courtesy of Cornell University.)

Fig. 142 shows how to distinguish a previous molt and the difference between a good and poor producer. The newly grown feathers (1, 2, 3, 4, 5, in this case) are cleaner, less worn and broader at the tips (colored feathers are brighter and fresher). A comparison of the length of the feathers in the illustration reveals that the last feather to be replaced (No. 5) is not as long as the others near it. This indicates that the bird is a good producer. A poor producer would not show this break, because the molt would be continuous.

This particular condition is often seen on early hatched pullets that molted one or more feathers in the fall of their first laying year. However, when such a molt takes place on an early hatched pullet, the last feather dropped is often longer than the feather on either side. This is owing to the fact that the primary feathers, when renewed during the first adult molt or at the end of the first laying year, grow a little longer than their length during the pullet year. Care should be taken not to mistake the fall pullet molt for early summer molt. The only way of distinguishing this is by observing the order of the molt. When the pullet drops a few feathers in the

fall of the pullet year, she will begin her molt normally the next fall (Fig. 140). This permits the observer to detect the

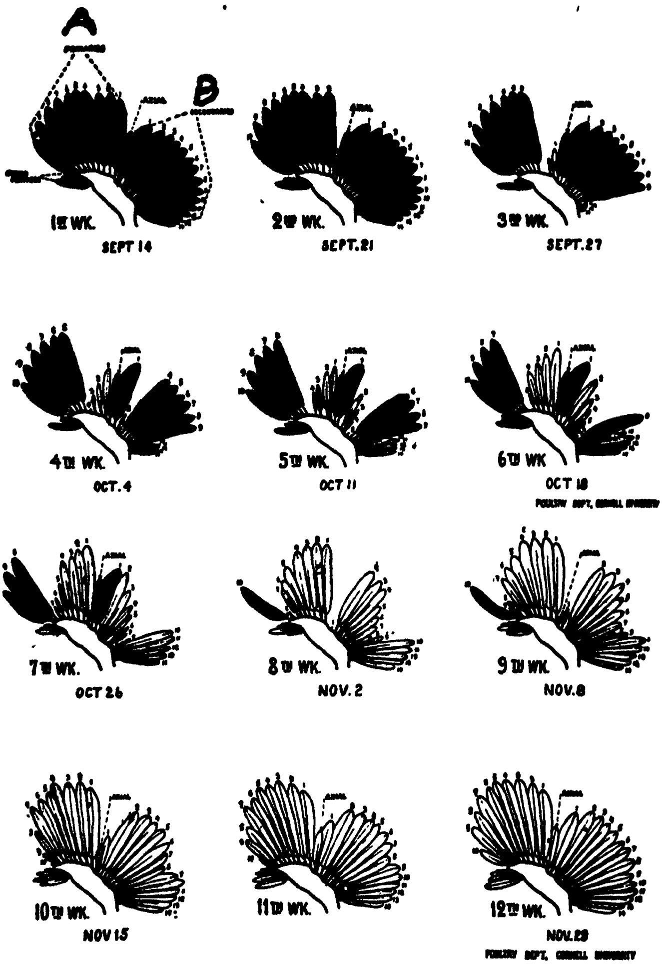


Fig. 143. The weekly change in the wing of a molting hen. (Cornell University.)

early summer molter, and will aid him in interpreting the molt of such birds as show the broken semicircle.

Further observations on molt. The molt of the secondary wing-feathers is not as regular and consistent as the primaries

and for this reason it is not as valuable a means of determining the quality of a bird. Observations show that the primary feather molt begins a few days ahead of the secondary wing- and tail-feathers in the case of birds ceasing production when molting starts. As long as the bird lays, molting of the secondary and tail-feathers is delayed, especially when the primary feathers are also being dropped. This is an important point for the culler to notice, for when the secondary and tail-feathers begin to drop, production usually ceases. With most birds this means that the year's production is over and they will not lay again until the molt is finished.

The commonest order of molt of the secondary wing-feathers, counting from the axial feather toward the body (Fig. 143), is as follows: 11, 12, 13, 14, 10, 2, 3, 4, 5, 6, 7, 8, 9, 1. Very often the first four or five feathers listed above will drop at approximately the same time. This is true also of the second, third, fourth, and fifth feathers. Nearly all birds will drop two or more feathers at the same time during the molt of the secondaries. The axial feather and the No. 1 secondary feather always drop at the same time.

The order of the tail molt is not uniform. The most common occurrence, in good producers, is a complete dropping of all tail-feathers at one time. Where this does not occur, the innermost pair of feathers usually drops first, then the others work outward in pairs.

It is well to remember that the molt is easily affected by feeding, sudden changes, and management in general. Insufficient food of the proper kind, especially the lack of animal protein in the ration, is a very common cause of premature molting. Under normal conditions, however, the molt offers a more reliable guide in culling or selecting hens in the autumn than pigmentation. This may not be true in the spring.

Chick molting. Many poultry-keepers are unaware of the fact that the baby chick passes through at least four partial or complete molts during its development to maturity.

INTENSITY OF PRODUCTION

Many hens in nearly every flock lay a fairly large number of eggs during the period of a year largely because they are persistent layers. They perhaps may not lay more than fifteen or twenty eggs a month but by continuing to lay for so many months they make up for the low rate. The best type of hen, of course, not only has persistency but the intensity as well, and the health and vigor which is so necessary under these conditions to maintain high production over a long period. The intensity of production is judged to a large extent by body capacity, appearance and type of head, and quality of the skin.

Body capacity. The high-producing hen has a deep, long, broad body, flat and wide at the hip joints, with this condition well sustained toward the tail. The pelvic bones, which are attached to the side of the back, spread out and fill in the sides of the body, so that the back has a sense of squareness like the feeling of a block of wood when the hand is passed closely over it. The heavy layer is also deep in body from the wing joints to the breast-bone, and this depth increases toward the rear of the bird. The keel-bone is long and straight, although it may be curved if the trend of the curve is parallel with the back. If a cross-section of the body is taken, it should be heart-shaped rather than round.

The low producer is the opposite in type. It is short, narrow and round in body. The back is arched, the hips pinched and sloping; the pelvic bones turn in and the keel-bone bends up toward the back.

When seen in the pen and viewed from above, the back of the low producer has an upright position and is comparatively narrow across the shoulders. The high producer carries the back more nearly parallel with the ground and is broad at the wing joints. Birds with good vigor and body capacity, whether walking or standing, usually have a three- or four-finger span

between the hock joints. This is a particularly important point in judging males.

The interesting point about body capacity is that it can be used at any season of the year, for the bony framework of the hen, especially the heart girth, does not change much either in or out of laying. However, body capacity is not an infallible test of production. Recently, as the result of taking a large number of measurements of bodies and checking them with the production of the hens, Hall of the Poultry Department at Cornell University is convinced that all hens of high production must have good capacity, but not all birds that have capacity lay well. In other words, body capacity as well as high production is an inherited character. High production requires capacity, but capacity may be present without great production.

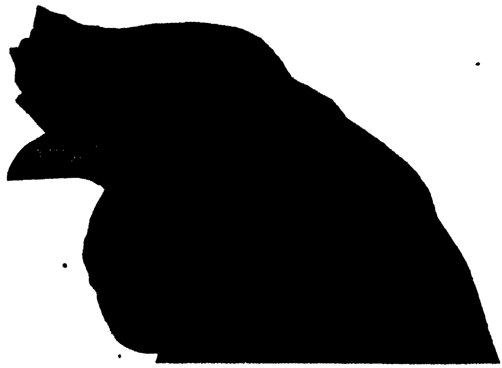


Fig. 144. A refined type of head. The world's champion egg-producing hen; 352 eggs in 365 days. (Official record.) (University of British Columbia.)

The head. It is possible with a little practice to tell the quality of a hen as a layer by studying her head. Foreman divides them into five classes.

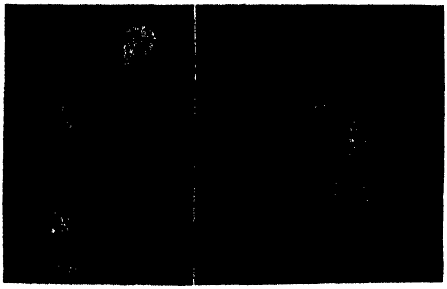


Fig. 145. Overly refined head. (Cornell Univ.)

1. *The refined head* (high production). (Fig. 144.) The hen of high production has a head well proportioned, of medium size, broader at the

top than at the bottom. The skull is slightly flat on top with a distinct line over the eye toward the beak. The face is smooth, plump and of fine texture. The beak is moderately long and arched while the comb is usually of fairly good size for the breed. This denotes strength and vitality. The eyes are large and bright and stand out from the side of the head like shoe-buttons when viewed from the rear. All these items, together with the extra fine quality of the skin on the face and comb, give the bird a keen, refined and intelligent expression.

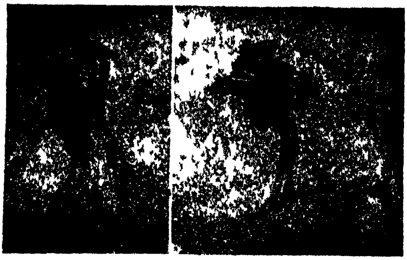


Fig. 146. Crow-headed hen. (Cornell University.)

2. *The overly refined head* (high production without vitality.) (Fig. 145.) Sometimes a hen may have the refinement and quality about the head that indicate great intensity of production, but she may lack the vitality to carry it out over a long period. Such over-refinement is indicated by a small delicate comb, a hollowness around the eye, and a high-strung nervous temperament. Birds in this class are poor property, for they are hard to keep in flesh, lose pigment quickly, and often die before the end of the laying year, owing to the fact that they cannot stand the strain of continued heavy production. They are often the result of constant inbreeding without sufficient attention to the vitality of the matings.

Fig. 147. A coarse or fat-headed hen. (Cornell Univ.)

3. *The crow head* (medium producers). (Fig. 146.) This class of hens have long straight narrow beaks, dull eyes and shallow drawn-out skulls. Birds with such snaky looking heads are called "crow-headed" because they resemble a crow's head in shape. Birds of this type are usually poor producers and develop colds and disease readily. The young are slow in developing their feathers or starting to lay. This difference in development is noticeable in large flocks where there is a good opportunity for comparison of types. Sometimes the crow-headed bird has an aggressive active temperament and, under these conditions, it may make a fairly good layer, but ordinarily a bird in this class is a poor layer and is unprofitable.

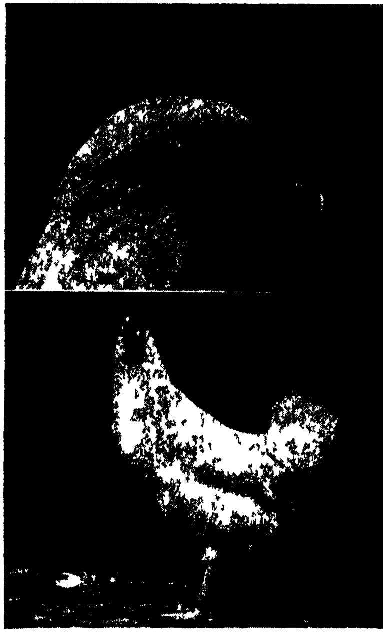


Fig. 148. Hen with masculine type of head. (Cornell University.)

4. *The beefy head* (low producer). (Fig. 147.) A hen of this class has a thick and round skull, the face is wrinkled and coarse, the eyes are large, inactive and surrounded by such a cushion of fat that they seem sunken in the skull. The beak is short and stubby and the neck just below the skull is large and throaty. The whole appearance of the bird indicates a sluggish lazy disposition and an inclination to take on fat at the expense of production. Birds with such heads are exceedingly poor layers and are better adapted to meat purposes than egg production.

5. *The masculine head* (abnormally low producer). (Fig. 148.) Lastly some hens develop tumors or permanent atrophy

of the ovary. Such hens may never have been good producers and probably will not lay an egg in the future. Hens in this condition take on the masculine characters to a large extent. In some respects they resemble the beefy type, with the exception that they develop long wattles and gouty coarse faces. The comb is large and coarse like the male and does not expand and contract or change color like the average hen. It is needless to say that this last type of hen is useless as a layer and may be worthless for table purposes.

Handling quality. In handling high- and low-producing hens there is a difference in the "feel" of the body. The good layer has a sense of unexpected weight. It seems almost as though the bird is filled with lead. This heavy feeling is due to an abundance of fat throughout the body and the size and condition of the internal organs, for the laying hen must be physically fit to produce well.

A change in the condition of the fat takes place when the hen stops laying. The abdomen, instead of being well rounded out, soft and pliable, begins to contract and the fat accumulates in a hard lumpy mass. This variation of condition between laying and non-laying is less marked in the low producers because they carry considerable hard fat most of the time. It is well, however, in this connection to keep in mind that the older a hen, the more likely she is to carry hard fat regardless of her intensity of lay. Leghorns and other similarly light-weight breeds are less likely to have hard fat in the abdomen than birds like the Plymouth Rocks, Wyandottes, or Rhode Island Reds. The use of large quantities of liquid milk or semi-solid buttermilk generally produces more hard fat than do other kinds of food. A hen that has a large lump of hard fat sagging way below the end of the keel-bone is usually of sluggish temperament and moderate production. The accumulation of large amounts of hard fat in the abdomen and throughout the body is probably due to the fact that the hen's

food, instead of being used for egg production, is stored away as fat.

The skin. A thin elastic skin that feels fine and silky to the touch, is also an indication of quality or intensity of production. The best place to notice this is around the abdomen and along the keel-bone. Coarseness or fineness of the skin is easily observed about the head.

Temperament. The temperament of a hen is worthy of consideration. A little study and observation will show that there is just as much variation among hens in this respect as among humans. If more attention were given to temperament in caring for hens and selecting breeding stock, better egg production undoubtedly would result. There is a considerable difference in the temperament of the breeds. Breeds like the Leghorns are more excitable and high-strung than the Brahmas or even the general-purpose fowls. Egg production seems to demand an active and nervous temperament, but one under control.

Foreman groups hens according to their disposition and temperament as follows: First, the highly excitable hen that squawks, flies, and thrashes around when caught. This type is usually a very poor producer. Second comes a class of birds less active perhaps than the first but still lacking the aggressiveness of the best layers. They may be termed as ambitionless. Third, there is a class of rather good hens that are inclined to wear themselves out by restlessness. They cannot endure heavy and continuous production over long periods. Next comes a group of birds that are quiet but ambitious; they are always working, yet they lack the snap and pep of the best producers and are inclined to be mechanical in their movements. Such birds just fall short of attaining what is expected of really good layers. Lastly comes the type that combines all the good points of the other groups. This type is intelligent, friendly and aggressive. There is no noise nor violent struggling when caught, for, although their nervous systems

are active and sensitive, they are under control. These hens are hearty eaters and tireless workers, and as a result are usually found on the outside perches at night for they are the last to go to roost and the first to come down for food in the morning.

Early maturity, or precocity. The age at which pullets mature and the time they stop laying are factors closely related to the amount of their production. The average early-laying pullet generally makes the best-laying hen through the year and is the last one to stop laying. Likewise the reverse is true, that the slowest to mature is the first to stop and therefore the poorest layer. By banding pullets of the same age with different-colored leg-bands according to the month in which they begin to lay, it will help considerably the next summer and fall in culling and selecting the flock, because it will furnish a definite check on the order in which they began to lay and the length of time each bird has been laying. Pullets that begin to lay late in the winter, due to being hatched later in the season, usually stop laying the following fall at about the same time as the earlier-hatched ones. They can never make up the time lost because they were hatched on a later date.

Early feathering over the back, quick development of the comb, and rapid body growth, are also indications of early maturity.

Broody hens. If a hen is marked each time she is broody with a leg-band of a certain color, it will help when culling to determine the type of layer she is and what has happened to bring about certain changes in her condition. Usually, when a hen has been broody three times in one season she should be discarded, for too much time is being lost to justify keeping her as a layer. Furthermore, such a marked tendency toward broodiness is likely to be transmitted to her offspring, if she is used as a breeder.

XVII. Selection and Management ot Breeders for Egg Production

AFTER the culls have been removed and the better birds saved, the final selection and mating of the breeders remains. At this point, to make the best use of the material at hand, a breeder must have clearly in mind a certain standard, and plan to make his selection accordingly. Records of breeding are shown in Tables XXXV to XL, pages 397 to 403.

"The degree and the rate of improvement are dependent to a considerable extent upon the skill of the person who makes the selection. Three techniques of selection are recognized. These may be used singly or in combination. They are:

"Selection of individuals for breeding on the basis of their own apparent characteristics, namely;

(a) Physical selection, using as criteria, size, condition, pigmentation, molt, and other factors.

(b) Selection on the basis of individual trapnest record."

"Selection on the basis of pedigree

"This technique of selection is based on the fact that matings of superior individuals bred from superior individuals are more apt to produce superior progeny than are matings of superior individuals from unknown ancestors. In this method of selection, three-generation pedigrees are superior to one- or two-generation pedigrees. Pedigrees beyond three generations are usually of little importance."

"Selection on the basis of family performance

"This method involves the use of the sib test and the progeny test. Prospective breeding males and females are selected on the basis of the performance of their sibs; that is, brothers and sisters. Or the selection of breeding individuals may be based on what their offspring (progeny) have already accomplished. The term 'family testing' therefore includes both sib and progeny tests."

"No doubt progress can be made by the first two techniques. However, the second method depends to a considerable extent upon the first. Likewise, the third method, the most effective of the three, is dependent upon the first two. For the most certain and rapid improvement, *a combination of the three methods is essential.*"[1]

ESSENTIAL POINTS IN PHYSICAL SELECTION

Time of year. As has already been indicated, the principal part of the selection of the females, as well as the males, should be in the late fall and early winter. At this time all the best birds should be banded for identification, if it has not already been done. Bands are also necessary for trap-nesting, if a system of pedigreeing is followed. The final selection, however, should not be made until the birds are mated. Of course some selecting should be done through the year when birds lose their health or do not measure up to what is expected of them.

Vigor (Fig. 150). Health should be the first consideration in breeding for egg production, because a lack of it affects the vigor of birds, and this in turn affects the egg production, the fertility, the hatch, and the growth of the chicks.

Birds of vitality are generally of good size for the breed and full of life and energy. The heads of such birds are well proportioned and strong, the eye bright, full and prominent, the comb rather large for the breed and its color a brilliant red unless the bird is a female and not laying, the body fairly long, deep and broad with the legs straight and set well apart, the feathers clean, healthy and well kept although somewhat broken and worn at times from long hard usage. Birds of low vitality are the opposite of this. They are crow-headed and have long slim necks and bodies. The eyes are deep-set and lack lustre, the combs are usually small and slow to develop, the legs are so close together that the bird is knock-kneed when it walks, and the plumage is sometimes ill-kept.

[1] J. H. Bruckner in "Poultry, Current Science and Practice."

Outstanding defects. While examining birds for constitution vigor, they should be inspected for other physical and breed defects. Most defects do not interfere with a hen's laying but may affect the quality of the egg produced or the appearance and sale of the bird, and consequently such birds should not be allowed in the breeding pen although they may be retained as layers. Birds having the following defects should not be included in a choice breeding pen.

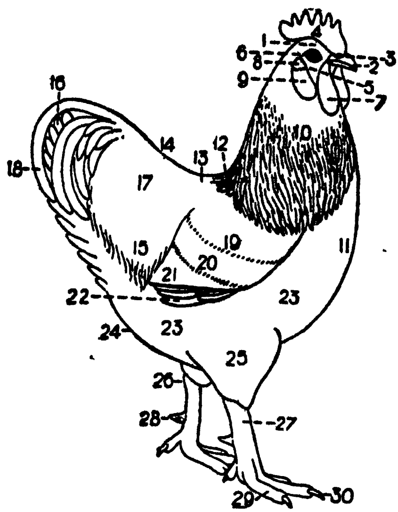


Fig. 149. Nomenclature of a fowl. 1, head; 2, beak; 3, nostril; 4, comb; 5, face; 6, eye; 7, wattle; 8, ear; 9, earlobe; 10, hackle; 11, breast; 12, cape; 13, back; 14, saddle (in female, cushion); 15, saddle feathers; 16, male tail-feathers; 17, tail coverts; 18, sickle feathers; 19, shoulder; 20, wing coverts; 21, wing secondaries; 22, wing primaries; 23, body; 24, fluff; 25, thigh; 26, hock; 27, shank; 28, spur; 29, toe; 30, toe-nail.

Crooked beak. Where one mandible crosses over the other, or is twisted so that it interferes with the bird's eating.

Crooked back or roached back. Sometimes the back is crooked or arched near the hip joints.

Rumpless. Without the rump which carries the tail-feathers.

Decidedly wry tail. The tail turned permanently to one side of the body, instead of being straight behind the head in line with the body.

Decidedly squirrel tail. A tail so carried that it projects forward over the back beyond a line drawn through its base and perpendicular with the ground.

Slipped wing. A wing not closely folded and held in proper position.

Split wing. A wing so irregularly formed as to show a

distinct gap between primaries and secondaries.

Defects of the eye. Any color other than the natural one for the breed.

Fig. 150. Comparison between birds of high and low vitality. Bird on left should be culled. Note difference in comb development and effeminate appear-

Stubs. Short feathers which are found down the shanks and between the toes of clean-shanked breeds.

Defects of shanks and toes. In four-toed breeds, more or less than four toes on either foot. In five-toed breeds, more or less than five toes on either foot. Legs and toes of color foreign to the breed.

Side sprig. A well-defined pointed growth on the side of a single comb.

Decidedly lopped comb. A comb falling over to one side. This applies to all male birds that have single combs.

Bad thumb mark. A disfiguring depression which sometimes appears in the sides of a single comb.

Split comb. A single comb which is divided perpendicularly so that the two parts overlap.

Miscellaneous comb defects. Absence of spike or telescope

spike on rose-comb breeds and varieties, or any comb foreign to the breed or variety, should be rejected.

Defects of the face. Positive enamel-white in the face, or

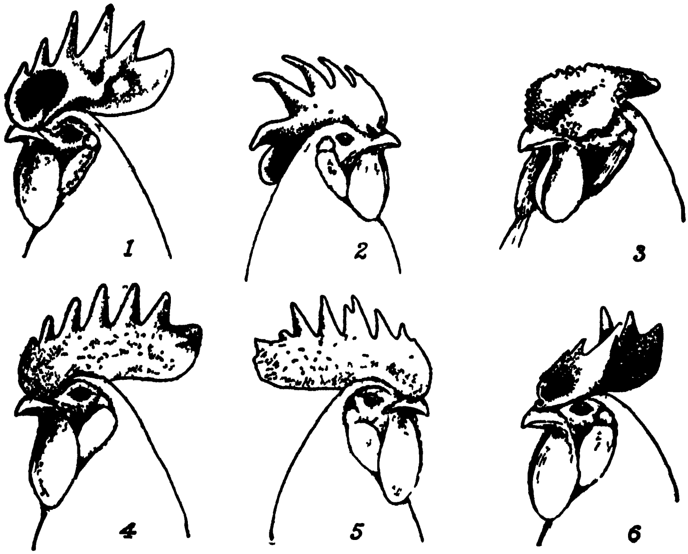


Fig. 151. Male heads illustrating common defects. 1, Thumb mark; 2, lopped (single); 3, hollow center, 4, side spring, 5, uneven serrations, 6, twisted. (U. S. D. A.)

positive red in the earlobes of Mediterranean breeds, or positive white in the earlobe of American or Asiatic breeds.

Defects in plumage. Red, white, or yellow feathers in any black breed. Brown, buff, or any other colored feathers in the plumage of white breeds.[2]

LONG LIFE (LONGEVITY)

Old birds that still retain their vigor generally make the *best* breeders. This is true of both males and females. The hen that lives for three or four years and produces well during that time and has the appearance of a yearling at that age, is an exceptional individual. Such a hen is more likely to trans-

[2] For further information in regard to other defects the reader is referred to the American Standard of Perfection

mit livability and production to her offspring. Recent information indicates that males whose mothers have lived for a number of years are more likely to transmit higher first-year livability to their daughters.

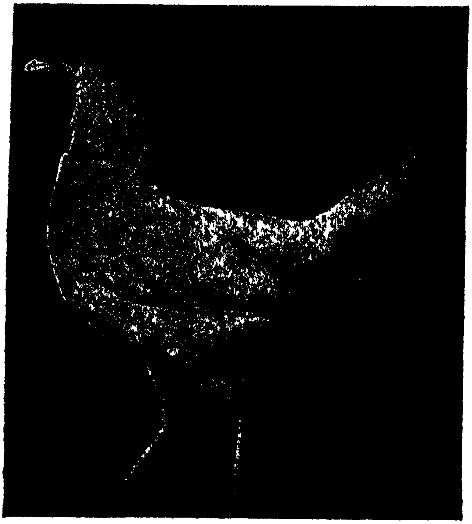


Fig. 152. A good type of Single-comb White Leghorn for egg production. Sweepstake hen in the production classes at the New York State Fair in 1926. (Homestead Farms.)

When a rigid system of physical selection is followed each year both with the old and with the younger birds in the flock, the older birds, having withstood so many more inspections successfully, certainly are worthy of first consideration as breeders. It is usually safer to use a vigorous old bird that has proven himself or herself capable of transmitting desirable qualities to their offspring, than a younger untried individual even though he or she gives great promise and has a fine pedigree.

The use of older breeding birds has some disadvantages. The males give poorer fertility and the hens lower hatchability. Fewer eggs are produced.

HIGH EGG QUALITY

The quality of the egg needs to be considered carefully. Often, in the struggle to increase the number a hen lays, the type of the egg is forgotten. A hen might better lay fewer eggs and have them marketable, than lay a large number of inferior eggs which will not command the top price on the market.

Only those hens that lay the proper size, shape, color and quality of egg which the market demands, should be selected. Trap-nesting is a great help in selecting hens for egg quality.

A large part of the benefits of selecting the hens for egg

Fig. 153. Hen entering trap-nest.

quality may be cancelled, however, if the pedigree and family history of the male are not taken into consideration. One should always use a male whose mother and family produced a desirable type of egg.

HIGH EGG PRODUCTION

As explained in another chapter, the egg production of hens can be determined either by trap-nesting or by selection by physical characters. Trap-nesting (Figs. 153–156) is the more accurate method and permits the breeder a more careful system of pedigreeing and progeny testing.

It is not necessary, however, to trap-nest the year round unless a complete annual record is desired for the pedigrees of the birds. The quality of the eggs, the intensity, fertility, hatchability and prepotency of an individual, may be found out by trapping just during the breeding season.

One of the great dangers in trap-nesting is that the breeder

often depends more on the trap-nest record than on the physical fitness of the birds as breeders. Both are necessary for success in breeding for egg production.

To trap-nest hens requires quite an investment in equipment, and considerable labor both in caring for the traps and in keeping the records, and is very confining for the operator. Consequently it is rather an impractical method for a farmer who does not desire to go into the breeding side of poultry-keeping very extensively. Selecting by physical characters, although it is not so accurate as trap-nesting, is close enough for practical purposes in flock mating and for this reason has been very popular in recent years. (See Chapter XVI for details.)

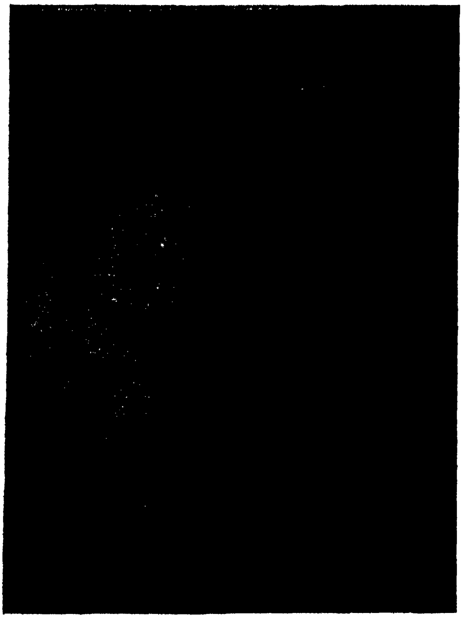


Fig. 154. Trap-nesting operation No. 1, removing the hen from the nest.

BRAIN POWER, OR TEMPERAMENT

An active alert brain is a very necessary part of the hen's body. It is the center of the nervous system and controls all the physical activities and functions of the body. A lack of nervous energy affects a hen's ability to lay by decreasing the efficiency of the digestive, circulatory, and assimilative systems.

Nervous energy is difficult to appraise, for there is no way of measuring it except by the appearance, actions and be-

havior of the birds. The breeder, therefore, who has the judgment and the eye to measure correctly the amount of nervous energy which the birds he chooses will develop, whether they are male or female, possesses one of the most important qualifications in selecting the chociest of breeding stock.

The head, being the seat of the nervous system, likewise gives most of the clues to the temperament of the bird. It is here, by the clearness and expression of the eye, the alertness and friendliness of the actions, the vigor and health as indicated by the comb and wattles, the symmetry of the head parts, and even the fine quality of the skin, that the bird is judged. In fact, a large part of the preliminary judging of hens, and especially of the cockerels and pullets, can be done by the appearance of the head without seeing the body at all. (For a further discussion of the head and the temperament, see Chapter XVI.)

Fig. 155. Trap-nesting ropeation No. 2, reading the band number.

CHOOSING FEMALES

When trap-nesting is done and complete pedigree and progeny-test records are available, the following factors or characters should be considered in selecting females: (1) egg production; (2) hatchability; (3) egg quality; (4) early feathering; (5) livability; and (6) standard breed characteristics. Table XXXIV gives certain breeding standards or goals for the various characters. These goals are based on research and the

experience of practical breeders. It may not be possible to attain all these goals at once. Some of the factors are more important than others. The problem is to maintain as high a level

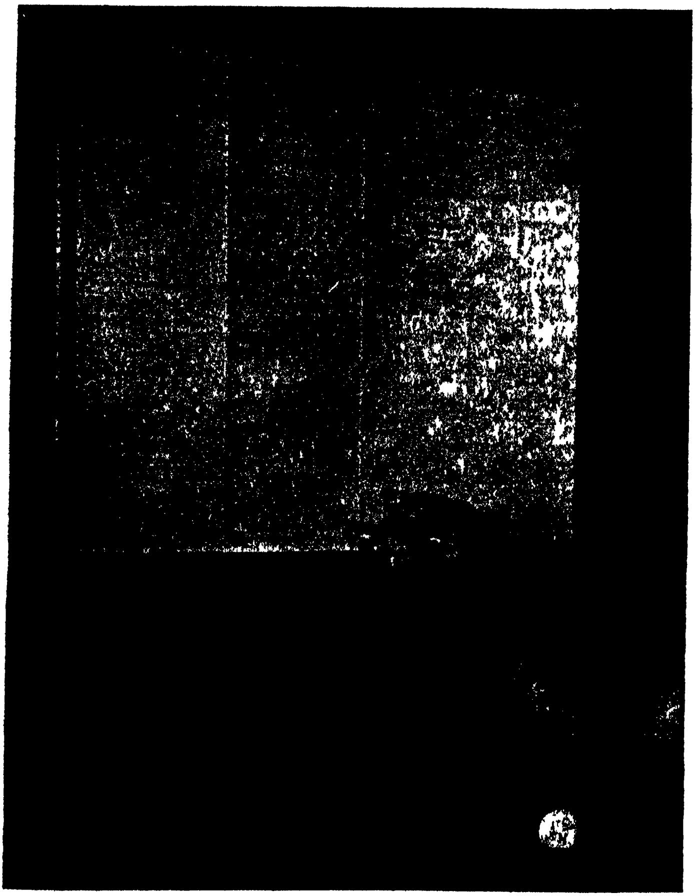


Fig. 156. Operation No. 3, trap-nesting. Record the numbers of the hen and the pen on the large end of the egg, and the hen number on the pen record sheet.

of quality in all factors as possible, and try to improve the ones that are weakest. In most flocks, livability, egg production, and hatchability are the most important factors to be improved.

TABLE XXXIV

BREEDING STANDARDS [8]

1. *Viability* (ability to survive)—Rearing mortality (aside from accidents, etc.) not to exceed 5% in any family.
   Adult mortality in first laying year not to exceed 10% in any family.
2. *Egg production*—
   (a) Early maturity—Average age of pullets at first egg in each family, for heavy breeds less than 215 days, for Leghorns, etc., less than 180 days.
   (b) Persistency—Average laying period of pullets in each family before molting, 315 days or more.
   (c) Intensity—Not less than 23 eggs monthly.
   (d) Non-broodiness—Never broody.
   (e) No winter pause of more than 7 days.
3. *Hatchability*—Average hatches of all fertile eggs of 85% or better for each family.
4. *Egg quality*—
   (a) Size—Mature egg size not less than 24 oz. per doz.
   (b) Color—For white-egg breeds, chalk-white shells, complete absence of tinted shells; for brown-egg breeds, uniform brown color.
   (c) Shape—Typical "egg shape"; absence of very long and very round eggs; absence of ridges.
   (d) Shell texture—Shells sound, strong, and free of roughness, weak ends and mottling.
   (e) Interior quality—Score by "Wilgus and VanWagenen." Scale not less than 2. (Page 268.)
5. *Feathering* (a problem in heavy breeds)—All chicks well feathered on sides and backs at 8 weeks.
6. *Standard-bred quality* *—Freedom from Standard disqualifications; reasonably true to Standard type and color for the breed or variety.

* The American Standard of Perfection classified fowls according to their appearance, not their economic value.

CHOOSING MALES

Greater care, if anything, should be exercised in selecting the males than the hens, owing to the fact that the male is half the flock. Males, like hens, should be selected for longevity, constitutional vigor, and freedom from defects.

The males should be judged for body type in the same way as are the hens. Males usually have a wider and deeper heart girth, proportionally, than do females. The body should be deep in front and well sustained toward the rear, but may be shallower in the rear than in a female. A long, straight or curved keel-bone is important and desirable.

The head of the male should be typically masculine. The

[8] Suggested by L. E. Weaver.

comb and wattles should be of good average size, rather inclined to be large than small.

In actions and temperament, males should be gallant, courageous and intelligent. The best male is not always the best fighter, although his presence should be respected.

A male with a good pedigree and family history is always preferred to one of unknown breeding, provided he has the proper physical characters. Such a male is much more likely to transmit desirable qualities to the offspring.

If pedigree and other records are available, attention should be given to the following factors in selecting a male: (1) production of three nearest dams; (2) per cent mortality, per cent culls, size of body, and production of full and half sisters; (3) egg quality of full sisters (size, shape, color and texture of shell); (4) rate of growth and maturity within a family.

Whenever possible, breeding cockerels should come from large families showing a high percentage of desirable characters. A good male may be used for more than one breeding season, if he remains physically fit.

Males may be progeny-tested without trap-nesting. The procedure is as follows: A number (from 15 to 20) of selected females are placed in each pen headed by 1 male. The more individual pens tested, the better are the chances of identifying superior males. Eggs from each pen are so marked that they can be incubated and hatched in separate trays. Chicks are toe-punched or wing-banded to indicate their sire. The pullet progeny of each sire, or a random sample of them, are housed by themselves. It may be desirable from the standpoint of efficient use of house space to test 100 daughters from each sire, but 50 give an adequate test. Unless all the daughters of a sire are kept, the sample should be made at random (that is, with no culling), with an equal number from each hatch. The test will have little or no value if only the most promising pullets are selected, as they would not be typical of the pullets produced by their sire. A record of

hatchability and range mortality can be kept for each male. With the progeny of each male housed separately, accurate records of average egg production, egg size, and total mortality can be obtained. This enables the breeder to determine which males are outstanding and worthy of repeated use.

The most accurate and complete information, of course, can be secured if full-time trap-nesting is practiced. However, recent information indicates that trapping 4 or 5 days a week will give practically as accurate information on the breeding characters of an individual as will full-time trapping.

Another short-cut is part-time trap-nesting. When this is practiced, each pullet from the different sires is trap-nested for at least four consecutive months beginning with the first egg laid, and for one month during the period from July 1st to September 30th at the end of the laying year. The birds should be hatched early enough so that the four-month period of trap-nesting will be concluded by January 1st, or soon after, and allow sufficient time for analysis of the records before the breeding season begins. Eggs should be weighed for six consecutive days during the fourth month of trap-nesting, and recorded on the trap-nest sheet. It is desirable to keep a flock record of egg production, mortality, and the hens sold as culls, during the months when no trap-nesting is done. Chicks from the different matings are individually pedigree-hatched.

MATING AND MANAGEMENT OF THE BREEDING STOCK

Many eggs are fertile within five days after birds are mated, but it is better not to begin saving eggs for hatching until the male has been in the pen for at least ten days or two weeks. If more than one male is used in the same flock, it may be desirable to extend the time to three or four weeks. The males will then become accustomed to their new quarters and to each other, and better fertility may result.

Usually, with active breeds like the Leghorn one male is allowed to about twenty females. As high as thirty or forty

females to one male has sometimes given good results, but such numbers are not generally recommended.

For American breeds, it is best to allow about one male to fifteen females; with Asiatic breeds, about one male to ten females.

Some breeders prefer to mate cock birds with pullets and cockerels with hens. Cockerels, when they are early hatched and well matured, are more active than some cock birds, and therefore are more likely to give better fertility, especially in large flocks.

When males are changed during the breeding season, at least one week must be allowed for the influence of the first male to expire, before the second one is placed in the pen.

Recent observations at Cornell University indicate that better fertility may result if the males are not given artificial light until about three weeks before the breeding season starts.

Better fertility sometimes results in flock matings if two lots of males are alternated twice weekly.

Loss of fertility due to frozen combs may be prevented by dubbing.[4] Dubbing has another indirect advantage. It permits males to feed from the ordinary mash feeders which have a reel or a wire grill, without catching their combs. Better fertility results because the birds eat more freely and keep in better condition. Even with undubbed males, better fertility results when feeders are used without reels or grills.

Developing cockerels should be placed in well-ventilated shelters on a separate grass range. To prevent fighting, not more than 40 or 50 should be kept in one flock; and to give each bird a better chance to eat, more than one hopper should be provided for the grain and mash. The cockerels should be left on the range as long as the weather permits. They should be housed separately and not placed in the breeding pens until the breeding season.

[4] The operation of removing combs and wattles of cockerels when the birds are three or four months old. (See page 490.)

The minimum weight of Leghorn female breeders should be 4 pounds; that of heavy breeds like Plymouth Rocks, Rhode Island Reds, and New Hampshires should be 5½ pounds.

METHODS OF MATING

On most poultry farms where many breeders are kept, a large number of hens and several males are placed in one pen together. This is known as flock mating. By this method a large number of hatching eggs can be produced at a minimum of expense and labor, but the quality of the offspring is usually not so good as that from a small flock of carefully selected and mated stock.

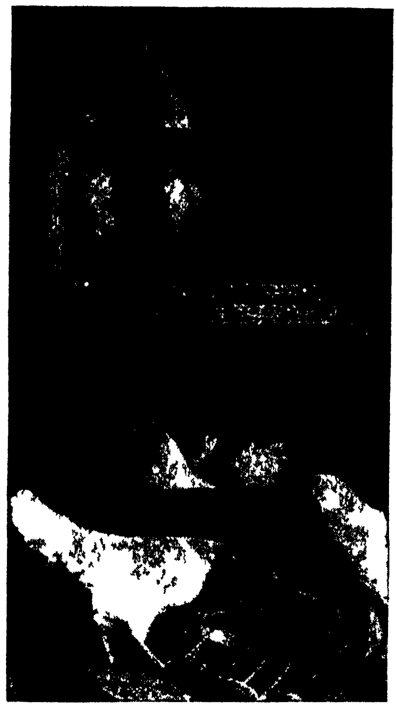


Fig. 157. Coops for stud mating.

When only a few hens are bred, or very choice matings are desired, the small-flock method may be followed. This consists in placing one choice male with the proper number of selected females in a separate pen. To make more rapid progress and have a choice of matings, at least five pens should be maintained so that a comparison of the offspring from the different matings can be made. This is highly desirable, as the prepotency of the males as well as of the hens varies greatly.

When the best of the male offspring of a single mating are to be used on the general breeding flock, great care should be taken to select a male and females that have demonstrated

their ability to transmit good qualities to their offspring, otherwise such a plan of breeding may do more harm than good.

Sometimes the breeder may wish to breed certain hens to certain males without going to the extra labor and expense of preparing small pens. This can be done by trap-nesting all the hens in a large pen and confining each male in a coop about 3 feet square by 3 feet high on the floor of the pen. The hens that are to be bred to one particular male are banded with a numbered band, of the same color as the band on the male. A record is kept of the number and color of the bands. As the hens are removed from the traps each day, they are placed in the coop with the male and allowed to stay there until the next round of the traps is made.

This method is known as stud mating (Fig. 157), and is usually not so satisfactory as the small-flock method because the fertility may not be good.

Breeding Plans.[5] To accomplish the most in breeding, a definite method of procedure should be followed to check up on the results of the different matings. With this idea in mind two plans are given, one without, the other with, trap-nests.

BREEDING PLAN NO. 1 (male testing)

PROGENY TESTING WITHOUT THE TRAP-NEST

1st Breeding Year.

Pen A	Pen B	Pen C	Pen D	Pen E
Male No. 1	Male No. 2	Male No. 3	Male No. 4	Male No. 5
20 Hens	20 Hens	20 Hens	20 Hens	20 Hens

*

* A system of punching the web of the feet of baby chicks to distinguish the chickens of one pen from those of another.

1. Keep eggs from each pen separate, and hatch separately.
2. Incubate only eggs of desirable type.
3. Give all females numbered leg-bands.
4. Band or toe-punch the chicks from each pen differently.

[5] These plans were worked out in coöperation with Dr. G. O. Hall, Cornell Univ.

5. Compare fertility and hatchability of the pens.

6. Check the source of the best cockerels and pullets when they are housed in the fall, and note their quality.

7. Compare the rearing and laying house mortality.

8. Handle the pullets in December or January following the first breeding year, and compare the offspring from the different matings as to number laying, size and quality.

9. A random sample of 50 or 100 or all daughters of each sire should be housed separately, thus affording a comparison on production, size and color of egg, and mortality.

2nd Breeding Year.

Pen A	Pen B	Pen C	Pen D	Pen E
Cock No. ?	Cock No. ?	Ckl. No. 6	Ckl. No. 7	Ckl. No. 8
20 Hens	20 Hens	20 Hens	20 Hens	20 Hens

1. Use two of the best cocks from the previous year in pens A and B.

2. Use three of the best cockerels sired by these two cocks.

3. Use the best old hens from the previous year's breeding pens.

4. Use in pens A and B a few of the very best daughters.

5. Fill up pens with the best yearling hens from the general flock.

6. Compare males as in the previous year.

3rd Breeding Year.

Pen A	Pen B	Pen C	Pen D	Pen E
Cock No. ?	Cock No. ?	Ckl. No. 9	Ckl. No. 10	Ckl. No. 11
20 Hens	20 Hens	20 Hens	20 Hens	20 Hens

1. Use the best two cocks mated in the 2nd breeding year.

2. Use three cockerels sired by these two cocks.

3. Use the best old hens from the previous year's pens.

4. Fill up pens with hens, the progeny of the previous year's matings or exceptional individuals from the general flock.

5. Continue from year to year, always selecting for size of bird, constitutional vigor, egg quality, and freedom from defects.

In the third or fourth breeding years new blood may be introduced by the use of a pedigreed male in one of the five pens. If the male is to be kept for further breeding, he should give distinctly better results than the other males used.

BREEDING PLAN NO. 2

PROGENY TESTING WITH FULL- OR PART-TIME TRAP-NESTS

1st Breeding Year. Select birds carefully, use pedigreed males if possible.

Pen A	Pen B	Pen C	Pen D	Pen E
Male No. 1 20 Hens	Male No. 2 20 Hens	Male No. 3 20 Hens	Male No. 4 20 Hens	Male No. 5 20 Hens

1. Give hens and males sealed numbered leg-bands.
2. Trap-nest during the breeding season, and pedigree the hatch.
3. Place numbered wing-bands on all progeny, with the sire's pen letter and the dam's leg-band number, with letter A to indicate the year the bird was hatched. (See Fig. 158.)
4. Cull at broiler age. Make notes of mortality and disposal of cockerels on hatching sheet.
5. Save all promising cockerels.
6. Save all old birds which are in good physical condition and have progeny.
7. All pullets, or a random sample from each mating, should be trapped, part or full time.

2nd Breeding Year.

Pen A	Pen B	Pen C	Pen D	Pen E
Cock No. ? 20 Hens	Cock No. ? 20 Hens	Cockerel 20 Hens	Cockerel 20 Hens	Cockerel 20 Hens

1. Use the best old hens from the pens mated in the 1st breeding year.

2. Select the best yearling hens from the general flock to fill the pens.

3. Select the best two males based on results of the 1st-year matings, and use in pens A and B.

4. Use the best two cockerels from male in A and the best one from male in B, in pens C, D, and E.

5. Trap-nest during the breeding season, and pedigree the hatch.

6. Place numbered wing-bands on all progeny, with the sire's pen letter and the dam's leg-band number, with letter B to indicate the year the bird was hatched.

3rd Breeding Year.

Pen A	Pen B	Pen C	Pen D	Pen E
Cock No. ? 20 Hens	Cock No. ? 20 Hens	Cockerel 20 Hens	Cockerel 20 Hens	Cockerel 20 Hens

1. Same procedure as above, except that yearling hens will be the progeny of the original 100 birds.

2. Each year, keep the best hens and the best two males regardless of age, as long as they continue to give good results.

3. Always keep your objective in view, the efficient production of high-quality eggs.

In the third or the fourth breeding year, new blood may be introduced as indicated in plan 1.

A SYSTEM OF PEDIGREE-BANDING CHICKS

The letters and figures on the wing-band as shown in Fig. 158 have the following significance:

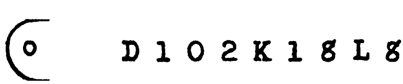


Fig. 158. A system of pedigree banding chicks.

D indicates that the sire of this chick headed pen D.

102 indicates the leg-band number of the mother of the

chick; the letter K, the year she was hatched.

18 indicates that this chick is the 18th chick hatched from this mating. The letter L shows the year the chick was hatched. This will be important in later seasons as explained above.

8 indicates that the chick is from the eighth hatch. This number must be stamped on the band at the time of banding the chick, and under no circumstances should it be left off. It is the key to the age of the pullet at her first egg.

IDENTIFICATION OF BIRDS

The identification of a superior male is partly a matter of chance; therefore the larger the number of matings to progeny-test males, the better is the chance of good ones. Five matings is the smallest number recommended. If less than this number is used, progress in improvement will be slow. The number of males tested may be doubled by changing males midway during the hatching season. Each male should have at least 50 daughters for an adequate progeny test, more are desirable. It is customary to compare the average value of the various characters in the offspring of each male with the average of these characters among the offspring of all the other matings. Those whose off-

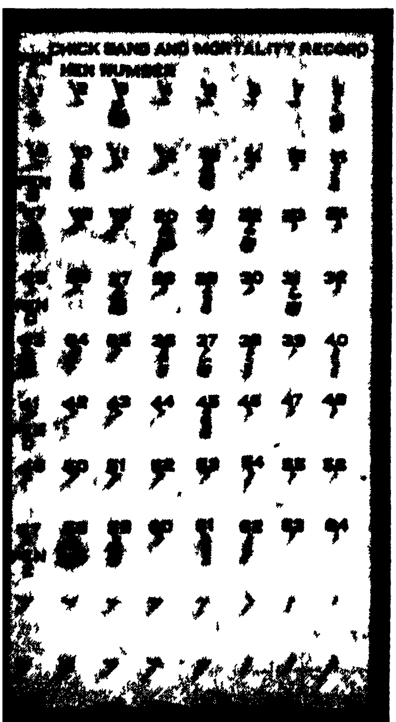


Fig. 159. Chick Band and Mortality Record Board. An easy way to keep the range mortality of pedigreed chickens.

TABLE XXXV

MONTHLY TRAP-NEST EGG RECORD, OFFICIAL

Pen No.______ Farm Name______ Owner______ Address______ Breed______ Month of______19______

Hen No.*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Month Total	Brought Forward	Total to Date	Egg Wt.	Hen Wt.	Remarks
X Eggs																																					
Total Eggs																																					

* Write month and year in spaces at top—Write hen number in space for each egg laid—Record floor-nest eggs as X eggs—Draw circle around broken-egg number. Write letter B in dates broody. Under remarks, record tinted egg as T; double-yolked egg as D; long egg as L; soft-shell egg as S; dead as dead; and out as O; also date observation is made of same.

TABLE XXXVI

FAMILY RECORD OF AN INDIVIDUAL HEN.

Hen No.__________ Mated to Male No.__________ Pen No..

WING BAND	YEAR HATCHED	1ST YR. EGG REC.	EGG WT.	MATURE BODY WT.	COLOR OF EGG	SHAPE OF EGG	EGG QUALITY	BROODY	ALIVE OR DEAD, JAN. 1, 19__.
	19								

HATCHABILITY AND RANGE RECORD FOR 19__.

DATE OF 1ST HATCH	EGGS SET	EGGS FERTILE	CHICKS HATCHED	% HATCH OF FERTILE EGGS	CHICKS BANDED	CHICKENS				COCKERELS SAVED	PULLETS HOUSED
						CULLED OR SOLD	LOST BY ACCIDENT	MISSING	TOTAL DEAD TO HOUSING		

RECORD OF DAUGHTERS FOR YEAR 19__ TO 19__.

DAUGH. LEG-BAND NO.	EGG PRODUCTION												TOTAL	BODY WT. 1ST EGG	MATURE BODY WT.	EGG WT. 1ST EGG	MATURE EGG WT.	AGE AT 1ST EGG
	Aug.	S.	O.	N.	D	J.	F.	M.	A.	M.	J.	J.						
Total																		
Ave.																		

TABLE XXXVII

PROGENY RECORD OF MALE—A FORM FOR KEEPING THE MATING LIST, THE PROGENY RECORD, AND THE INDIVIDUAL ANNUAL RECORD OF HENS

Male No.______. Age______. Body Wt.______. % Mortality in Progeny 19____. Dam's Prod.______. Wt.______. Egg Wt.______

Pen______. Year______. No. Hatches______. Beginning__________, Ending__________. Farm Name____________________

		Hatching Record		Range Mortality			Daughters																		
										Ave. Doz. Egg Wt.		Ave. Body Wt.			Number Dead				Ave. Eggs per Daughter			No. Undesirable for				
Hen No. (1)	Used Previous Yr. (2)	% Hatch Fertile Eggs (3)	No. Chicks Banded (4)	Mort. from Disease (5)	Mort. by Accident (6)	% Mort. from Disease (7)	No. Culled Before Housing (8)	No. Housed (9)	Age at 1st Egg (10)	At 1st Egg (11)	At Maturity (12)	At 1st Egg (13)	At Maturity (14)	No. Culled in Laying House (15)	To Dec. 1st or Other Date (16)	Total for Yr. (17)	% Number Housed (18)	% Culled and Dead (19)	To Dec. 1st or Other Date (20)	No. Laying Dec. 1st (21)	12 Months (22)	Egg Color	Egg Shape (23)	Egg Qual.	Broody (24)	(25)
Total																										
Ave.																										

TABLE XXXVIII

A Comparison of the Progeny of Different Males

Date________ Year________ No. Hatches________ Beginning________ Ending________ Farm Name________

		Hatching Record		Range Mortality			Daughters																			
										Ave. Doz. Egg Wt.		Ave. Body Wt.			Number Dead				Ave. Eggs per Daughter			No. Undesirable for				
Pen No. (1)	Number Females (2)	% Hatch Fertile Eggs (3)	No. Chicks Banded (4)	Mort. from Disease (5)	Mort. by Accident (6)	% Mort. from Disease (7)	No. Culled Before Housing (8)	No. Housed (9)	Age at 1st Egg (10)	At 1st Egg (11)	At Maturity (12)	At 1st Egg (13)	At Maturity (14)	No. Culled in Laying House (15)	To Dec. 1st or Other Date (16)	Total for Yr. (17)	% Number Housed (18)	% Culled and Dead (19)	To Dec. 1st or Other Date (20)	No. Laying Dec. 1st (21)	12 Months (22)	Egg Color	Egg Shape (23)	Egg Qual.	Broody (24)	(25)
Total																										
Ave.																										

TABLE XXXIX

Individual Male Record

Male No.________ Date Hatched________ Date of Death________

Variety________ Defects________ Cause of Death________

Year	Mated to Hen No.	Number of Eggs Set	Percentage of Eggs Infertile	Percentage of Chicks Hatched	Number of Chicks Hatched	Number of Chicks Reared to Maturity		Number of Males Kept for Breeding	Number of Females Kept	Number of Females Trap-Nested	Average First-Year Production of Trap-Nested Daughters
						Males	Females				

spring show the largest number of characters above average make the best prospects.

The same procedure is followed in selecting hens. If a hen has less than 5 daughters, the hen and her daughters are rejected unless a previous test shows that the hen is a desirable breeder. At least 5 daughters are considered necessary for an adequate test for egg production. A larger number may be necessary for other characters. As with the males, the average value of the various characters in the daughters of a hen is compared with the average of these characters among the daughters of the other hens in the same mating. Those whose offspring show the largest number of characters above average make the best prospects.

TABLE XL

REVERSE SIDE OF FORM SHOWN IN TABLE XXXVIII

			Dam number
		Sire number	Record—1st year eggs
			2d year eggs
			3d year eggs
			Sire number
	Sire number	Dam number	
		Record—1st year eggs	Dam number
		2d year eggs	Record—1st year eggs
		3d year eggs	2d year eggs
			3d year eggs
PEDIGREE OF Number		Sire number	Sire number
	Dam number		Dam number
	Record—1st year eggs		Record—1st year eggs
	2d year eggs		2d year eggs
	3d year eggs		3d year eggs
		Dam number	
		Record—1st year eggs	Sire number
		2d year eggs	
		3d year eggs	Dam number
			Record—1st year eggs
			2d year eggs
			3d year eggs

XVIII. Principles of Breeding Poultry for Egg Production

THE value of good breeding is coming to be recognized, but the principles underlying it are so complex and varied that they are not generally understood.

"Breeding is the science and art of mating animals or plants with the expectation of securing in the offspring definite results in the development of certain specific characters. These characters may be vigor, longevity, type, habit, plumage, prolificacy, egg quality, meat quality, rapidity of growth, broodiness, etc. The forces that produce these qualities exist in the body cells of the individual and are increased or decreased by selection and breeding." [1]

Progress in breeding poultry comes by providing a favorable environment, such as comfortable houses, food, and the like, and by having a knowledge of the factors which are likely to affect selection. Selection is the key-note of progress. It is through a careful method of selection that the breeder can hope to bring about new and more valuable characteristics, and maintain the good points he desires. Of course, natural selection has influenced and modified animals and plants since the beginning of time, and is still slowly and unconsciously at work. Under natural conditions only those animals and plants survive that are best fitted to the environment in which they happen to live, whatever it is. The needs and desires of man are not considered. Usually, only the most active and vigorous survive, and so, even if in-breeding does take place, it is not so harmful as under domestication, where the weak, as well as the strong, have a better chance to live because the environment and breeding are largely controlled by man. The rapidity

[1] Rice and Botsford, "Practical Poultry Management."

and success with which a breeder accomplishes certain ends will depend on his ability to understand how to control heredity. Poultry breeding probably never will be reduced to an exact science, for it is very complex and far-reaching. The final results and success of breeding will depend to a large extent on the skill of the breeder. He must know how to select breeding stock that will most probably transmit the desired qualities to their offspring.

A brief explanation of laws or principles which affect the selection of breeding stock is essential.

FACTORS CONCERNED IN BREEDING

Heredity. Heredity is the transmission of morphological or physiological characteristics or qualities from parents to offspring through their reproductive cells. The science which deals with heredity and the origin of individuals is *genetics*.

The body of the chicken is made up of many characters. It is easy to see such morphological characters as type of comb, type plumage, or shape of body, but the physiological characters such as egg production, rate of growth, or broodiness are hidden and cannot be readily seen. It is clear, therefore, that the physiological factors are much more difficult for the breeder to study and handle than are characters that can be seen.

From heredity arises the saying, "Like begets like." For example, when White Leghorns are mated together, one may expect the chicks to be White Leghorns and to resemble closely their parents in shape, color, size, and egg production.

The crowing of the males, the cackling of the hens, even the laying of eggs, are all fixed characters which have been handed down from one generation to another, and so on back to the beginning of time.

On the other hand, while the law of heredity is relentless and inflexible in its working, while like begets like in a general sense, still there is a strange contradiction to it all. For

example, the number of points on the comb of a flock of White Leghorn males may vary from three to eight or more; in this case the birds are alike, because they all have combs, but the type of the combs varies according to the number of points. Likewise there are differences in the hens. While all the hens in a flock may lay white eggs, still some may lay only 10 in a year, while others lay 300.

Variation. Variation is the deviation in structure or function of the offspring from the type of the parents. In other words, no two individuals are absolutely alike, even though to all appearances they look and act the same. Variation gives man an opportunity to change or improve his stock, by selecting the characters best adapted to his needs, and then fixing them by a careful plan of breeding. The rapidity and certainty with which characters are more or less fixed varies greatly. Extensive changes may take place at once, or only prove to be a flash in the pan. There is no certainty that every 300-egg hen, for example, will exert an influence on her offspring toward high egg production, although the chances of securing high production are better if she is bred to a male from a 300-egg hen, especially if both come from a strain of high producers. There is no hard and fast rule that will tell in advance whether a male or a female will breed true or not. The sure way is to test them in the breeding pen. It is easy to see, therefore, that to make the most of this matter of variation, the progressive breeder must be a keen observer and a deep thinker, and must exercise careful judgment.

Mutations or sports. Mutations are sudden deviations from the normal type. Mutations apparently are unlooked-for new types which do not come as the result of a process of selection. They are most commonly called "sports." Many new varieties of poultry have resulted from breeding sports. Whether or not mutations are used will depend on the type of mutations.

Reversion, or atavism. Reversion, or atavism, is the tend-

ency of animals and plants to transmit characters to their offspring which have been latent in the parents for one or more generations. The causes which produce this breeding-back do not always manifest themselves in the parents. Sometimes cross breeding, outcrossing or inbreeding will bring out these characters. This is often demonstrated when two strains of birds of one variety which have been bred to the point where broodiness is not apparent are crossed, and a large amount of broodiness appears in the offspring. This is due to the bringing together of recessive or complementary characters which permits the character in question to express itself in the offspring. Another example of reversion is seen when buff feathers appear on the breasts and wings of White Leghorns. Some remote ancestors utilized to form this breed had colored plumage.

Prepotency. Prepotency is the ability of a parent to transmit its qualities and characteristics to its offspring. These qualities may be either desirable or undesirable. Parents vary greatly in their potency. Full brothers or sisters sometimes vary considerably in their ability to transmit a certain characteristic to their offspring. Just because a male or a female has a fine pedigree is no indication that the offspring will have the same characteristics as the parent, although the chances in such a case will be better because of purer blood lines.

In breeding for egg production, a hen not only must be a good layer herself, but must transmit the quality of egg production to her daughter as well, to become a good breeder.

It is easy to see, therefore, that the question of prepotency is of great importance to a breeder. Ordinarily, progress in breeding is slow, but by the introduction of a decidedly prepotent individual into a flock more may be accomplished in a single generation than in a long term of years preceding. The only way the prepotency of an individual can be determined accurately is by watching its offspring. In case egg production

is desired, this will mean trap-nesting the daughters of a mating and pedigree-banding the sons.

Progression means that the quality of the offspring exceeds the average of the stock from which the parents were selected. It is only by continually selecting breeders of a type better than the average of the flock that progress can be made.

Regression is the opposite of progression. It means that the quality of the offspring is inferior to that of the average of the stock from which the parents were selected. When no selection of any kind is practiced, the tendency is backward toward an average, or mean. Selection, therefore, is absolutely necessary to maintain a certain standard of excellence, even if no further progress is desired.

THE DEVELOPMENT OF A NEW INDIVIDUAL

Perhaps a better understanding of the development of an individual will help to explain some of the mysteries of genetics.

Each chick or individual has certain peculiar characteristics. The development of these characters does not begin when the chick is hatched, but long before that time. Many of its future mature characteristics have been very definitely determined by its ancestry. Each chick or individual is unavoidably linked to its ancestry through its germ cells.

The existence of an individual begins as a single cell. This single cell, which is so tiny that it cannot be seen without the help of a microscope, is formed by the union of two original germ cells, one from each parent. The union of the two germ cells is known as *fertilization.*

The reproductive cells are produced by the reproductive organs, or *gonads,* of the parents. The ovary of the female produces *ova* (singular is ovum), or eggs, and the testis of the male produces *spermatozoa* (singular is spermatozoon). Fertilization of the ovum takes place by the union of ovum and

a spermatozoon. The fertilized egg under proper conditions develops into a chick.

All reproductive cells are called *gametes*. The ovum is the female gamete and the spermatozoon is the male gamete. The union of the female and the male gamete produces the fertilized egg, which is called a *zygote*. The zygote when given the proper conditions for incubation develops into a chick which may be either a male or a female. Each gamete, or reproductive cell, has a central area of development called a *nucleus*. Within this area are long thread-like bodies called *chromosomes* which are transmitted from parent to offspring.

Careful study of the chromosomes reveals that the number varies with the species of animal, but in the chicken the number is 79 or 80: 79 if it is a female and 80 if it is a male. The number of chromosomes is constant for every species of animal. The difference in the number of chromosomes between the male and the female is due to the fact that the male has two sex chromosomes while the female has one.

There are two kinds of chromosomes. The sex chromosomes, as their name indicates, are primarily the determiners of sex, while the other chromosomes are called autosomes, or ordinary chromosomes.

Since the autosomes, or ordinary chromosomes, occur in pairs, a male chicken therefore has two sex chromosomes and 39 pairs of ordinary chromosomes, while a female chicken has only one sex chromosome and 39 pairs of ordinary chromosomes. By a process known as reduction at one stage in the formation of the daughter cells, the number of chromosomes is reduced by half so that each has half the usual number of chromosomes. When the reproductive cell divides, each new cell contains the same kind and number of chromosomes as the parent cell. At the time of cell division to form gametes, one chromosome of each pair goes into each gamete; thus each male gamete has 39 autosomes. The female produces two kinds of gametes. Half of them contain autosomes with a sex

chromosome, and the remainder have autosomes but no sex chromosome. When a male gamete fertilizes a female gamete which has a sex chromosome, the zygote which results will have two sex chromosomes and will develop into a male. However, if the male gamete unites with a female gamete without a sex chromosome, the zygote will contain only one sex chromosome and will develop into a female. When large numbers of fertilizations take place, about equal numbers of males and females can be expected.

In the process of division of the gametes there is a redistribution of chromosomes, but equal numbers go into the new cells. The regrouping of the chromosomes in the new cells occurs by chance. This permits many different combinations of characters.

The chromosomes are the carriers of the hereditary factors which determine characters. But, since there are hundreds of characters and only 39 pairs of autosomes, or ordinary chromosomes, and one or two sex chromosomes according to sex, it is easy to see that each chromosome must be the bearer of many characters. Each chromosome contains very minute particles called *genes*. These genes are the determiners of hereditary characters. They determine whether a bird is to have red or white feathering, rose or single comb, high or low egg production, and many other characters. The characters the genes for which are carried on the sex chromosomes, are called sex-linked characters. A dam transmits sex-linked characters to her sons but not to her daughters. The sire, on the other hand, transmits the same characters to both sons and daughters alike. This is illustrated in Fig. 160 when a Rhode Island Red male is mated with a Barred Plymouth Rock female.

This diagram shows the inheritance of sex and the sex-linked character of barring. The Rhode Island Red male has 39 pairs of ordinary chromosomes and two sex chromosomes. S indicates the sex chromosome and b the gene for non-barring. The Barred Plymouth Rock female has 39 pairs of ordinary chromo-

somes, but only one sex chromosome. S indicates the sex chromosome and B the sex-linked gene for barring which is dominant to non-barring. The male offspring are barred, but the female progeny are non-barred or black.

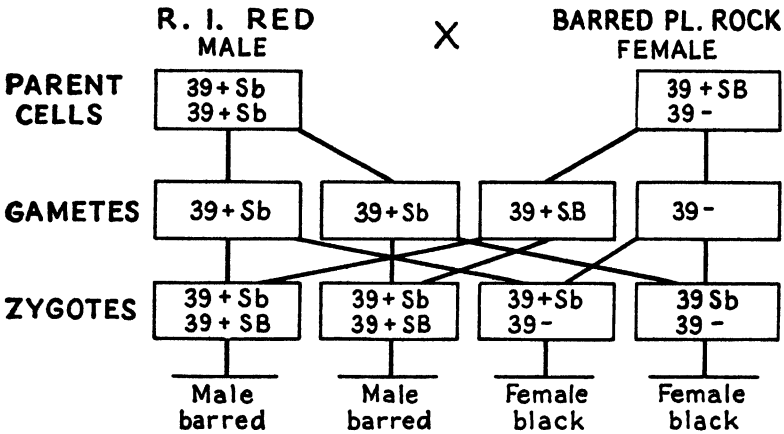


Fig. 160. This diagram shows the inheritance of sex and sex-linked character of barring. The male offspring from such a mating are barred and the females are black.

This shows that barring is a sex-linked gene, since barring results in an individual when one sex chromosome comes from the dam and is absent in birds getting a sex chromosome from the sire. There are many sex-linked characters. Some of them, such as early maturity or rapid feathering, are of practical importance.

Sex linkage can be utilized in mating birds to determine the sex of the chicks at hatching time. The distinction is made by the difference in down pattern or color. For example, when Barred Plymouth Rock females are mated with Rhode Island Red, New Hampshire, or White Wyandotte males, the female chicks (non-barred) will be all black on top of the body with dark shanks and beak, while the male chick (barred) will have the same color of body with a white spot on the head and yellow shanks and beak.

TABLE XLI[2]

Color of Adult Offspring from Crosses of the More Common Breeds and Varieties of Chickens

<table>
<tr><th rowspan="2">Female Parent</th><th colspan="7">Male Parent</th></tr>
<tr><th>White Leghorn</th><th>White Plymouth Rock</th><th>White Wyandotte</th><th>Black Varieties</th><th>Rhode Island Red</th><th>Buff Varieties</th><th>Barred Plymouth Rock</th></tr>
<tr><td>White Leghorn.....</td><td></td><td colspan="3">White, some black flecks</td><td colspan="2">White with some black flecks, may show buffish or reddish on surface</td><td>White, some black flecks</td></tr>
<tr><td>White Plymouth Rock............</td><td>White, some black flecks</td><td></td><td>White</td><td>Females black, males barred or black</td><td colspan="2">Females black or reddish buff; males black, barred, or Columbian pattern</td><td>Barred</td></tr>
<tr><td>White Wyandotte..</td><td rowspan="2">White, some black flecks</td><td>White</td><td></td><td>Mostly black</td><td colspan="2">Females reddish buff, males Columbian pattern</td><td>Barred</td></tr>
<tr><td>Black Varieties.....</td><td>Barred, but some black</td><td>Mostly black</td><td></td><td colspan="2">Mostly black, showing red</td><td>Barred</td></tr>
<tr><td>Rhode Island Red..</td><td rowspan="2">White with some black flecks and some red or buff on surface</td><td rowspan="2">Barred, black, or Columbian pattern</td><td rowspan="2">Usually Columbian pattern, some black</td><td rowspan="2">Mostly black, showing buff or red</td><td></td><td>Reddish buff</td><td>Barred</td></tr>
<tr><td>Buff Varieties......</td><td>Reddish buff</td><td></td><td>Barred</td></tr>
<tr><td>Barred Plymouth Rock............</td><td>White, some black flecks</td><td>Barred; some females black</td><td colspan="4">Females black, males barred</td><td></td></tr>
</table>

[2] From Technical Bul. 52, Kansas Agr. Exp. Sta.

When White Leghorn males, or males from practically any other breed of the Mediterranean class, are mated with females of the American, Asiatic, or English classes, the day-old female chicks will have well-developed feathers on the wings. The males will show none or very short feathers. Whenever it is desired to use sex-linked characters, the dominant character should be introduced through the female.

HOW CHARACTERS ARE INHERITED

The laws governing the inheritance of characters were first discovered by Gregor Mendel, an Austrian monk. He carried on breeding experiments for years, and finally published his results in 1866 in a rather obscure scientific journal. His work escaped notice until about 1900 when it was rediscovered. Mendel studied the inheritance of several pairs of characters and discovered that every pair of characters was inherited independently of every other pair. He made his investigations with peas, but later research proved that the same principles

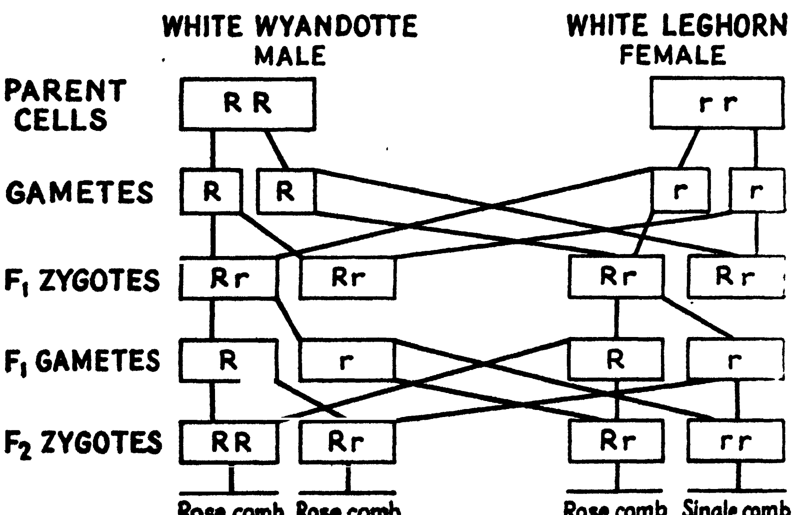


Fig. 161. The inheritance of two pairs of characters.

apply in general, except where the genes are close together on the chromosome, to both plants and animals.

Mendelian principles are illustrated when a single-comb White Leghorn hen is mated to a White Wyandotte male (Fig. 161). The Leghorns have single combs and the Wyandottes have rose combs. The gene for the single-comb character may be indicated by *r* and that for rose comb by *R*. The offspring in the first generation, or F_1, will have rose combs. Rose comb in this particular mating is said to be *dominant,* as it is the only one of the two comb characters which appears in the first-generation offspring. The single comb, which does not appear, is *recessive.*

When a single-comb (r) female is mated with a rose-comb (R) male, the first generation (F_1) have rose combs (dominant character). But the determining genes for single comb, though recessive, are still present in half of the gametes of the F_1 generation. This is shown to be true by the fact that when the offspring of the F_1 generation are mated among themselves, they produce birds which have rose combs and birds which have single combs, in the ratio of three rose-combs to one single-comb. In other words, three times as many rose-comb chickens as single-comb ones are produced in the second, or F_2 generation. It is apparent that some of the birds in the second generation carry determining genes for rose comb and others for single comb.

When R gametes from both sexes unite, the resulting zygote will carry the factors RR, which is *pure* for rose comb. On the other hand, if an R gamete of a male unites with an r gamete of a female, the resulting zygote will have the factors Rr. The offspring in this case will be rose-combed because R is dominant to r, but they will be *impure.* In a similar manner, when r gametes from both sexes unite, the resulting zygote will carry the factors rr and is pure for single comb. Birds that have a zygote which contains like genes for the comb character, RR and rr, are *homozygous.* In other words, they are pure for this

character. The birds with an Rr zygote are *heterozygous;* that is, they are impure for the comb character.

INHERITANCE OF TWO PAIRS OF CHARACTERS

In principle the inheritance of two pairs of characters is exactly the same as for one pair. If, for example (Figs. 162

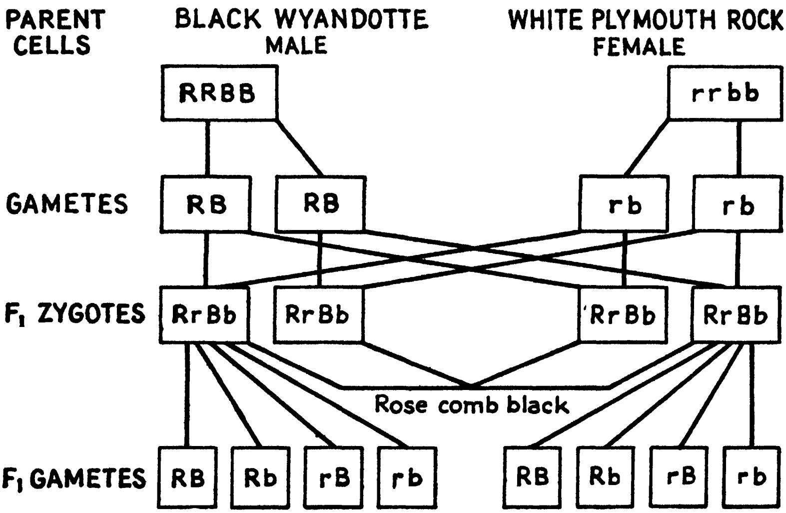


Fig. 162. A diagram showing the inheritance of two characters.

and 163), a Black Wyandotte, which is homozygous for rose comb, is crossed with a White Plymouth Rock, which has a single comb, each parental germ cell will carry determining genes for color and for comb type. The mode of inheritance can be easily worked out by using symbols to indicate the genes carried on the chromosomes. It is customary to represent a dominant character by a capital letter and a recessive character by a small letter.

Black (B) is dominant to white (b) and rose comb (R) is dominant to single comb (r). This mating gives four kinds of gametes in the first generation, instead of two, when one pair of characters was used, as shown in Fig. 160. The birds in

the first generation will all be black with rose combs; but when the F_1 birds are mated, four different combinations of gametes are produced (RB, Rb, rB, rb) by each sex. Thus

	FEMALE GAMETES			
MALE GAMETES	RB	Rb	rB	rb
RB	RRBB (Rose comb black)	RRBb (Rose comb black)	RrBB (Rose comb black)	RrBb (Rose comb black)
Rb	RRBb (Rose comb black)	RRbb (Rose comb white)	RrBb (Rose comb black)	Rrbb (Rose comb white)
rB	RrBB (Rose comb black)	RrBb (Rose comb black)	rrBB (Single comb black)	rrBb (Single comb black)
rb	RrBb (Rose comb black)	Rrbb (Rose comb white)	rrBb (Single comb black)	rrbb (Single comb white)

Fig. 163. The checkerboard plan of showing the kind of zygotes formed by mating two pairs of characters. R = Rose comb; B, black plumage; r, white plumage, b, single comb. See Fig. 162.

the number of possible combinations of characters is four times as great as when two kinds of gametes are united. (See Figs. 162, 163.)

Of the 16 zygotes formed, 9 will be rose-comb black, 3 rose-comb white, 3 single-comb black, and 1 single-comb white, a ratio of 9:3:3:1. If the comb character alone is considered, there are 12 rose combs and 4 single combs, or a ratio of 3:1; with color there are 12 blacks and 4 whites and the same ratio. These ratios are the same as would be expected when two characters are inherited separately, and are in accord with

Mendelian principles. Of the four different combinations of plumage color and comb type, two are new: one is homozygous for rose comb and white color, the other for single comb and black color. These zygotes are different from the original parents and those of the first generation, because they are produced only by the random distribution of the chromosomes.

THE INHERITANCE OF SEVERAL PAIRS OF CHARACTERS

It is easy to see how complex and varied the results are likely to be when large numbers of pairs of characters are involved and the different genes producing the characters are on different chromosomes. However, the segregation and assortment of characters is the same as the inheritance of a single pair of characters. With each character added, the number of different kinds of gametes formed by the F_1 generation is doubled. For every character that is added, there is an increase by four in the number of F_2 individuals required to secure the appearance of the various combinations of characters resulting from the chance combination of the different kinds of F_1 gametes (Table XLII).

TABLE XLII

NUMBER OF PAIRS OF CHARACTERS, NUMBER OF GAMETES PRODUCED, AND NUMBER OF F_2 INDIVIDUALS NECESSARY TO SECURE THE APPEARANCE OF ALL POSSIBLE COMBINATIONS OF CHARACTERS

NUMBER OF PAIRS OF CHARACTERS	NUMBER OF DIFFERENT F_1 GAMETES PRODUCED	NUMBER OF F_2 INDIVIDUALS REQUIRED TO SECURE ONE HOMOZYGOUS FOR ALL CHARACTERS
1	2	4
2	4	16
3	8	64
4	16	256

DOMINANT AND RECESSIVE CHARACTERS

The inheritance of about fifty characters has been established. Most of them have little economic significance. A few of most practical importance are listed in Table XLIII.

While most of these are simple characters, others are quite complicated. For example, the white in White Leghorns is not completely dominant to colored plumage. When mated to a

TESTING FOR PURITY OF CHARACTERS

Sometimes a recessive character may be carried in a flock for some time without being detected, if matings happen to

TABLE XLIII

SOME DOMINANT AND RECESSIVE CHARACTERS IN CHICKENS

CHARACTER	DOMINANT OR RECESSIVE	AUTOSOMAL OR SEX-LINKED
White plumage	In White Leghorns, dominant to color In Plymouth Rocks, Minorcas and Wyandottes, recessive to color	Autosomal
Black plumage	Dominant to recessive white	Autosomal
Buff plumage	Dominant to recessive white	Autosomal
Barred plumage	In Plymouth Rocks, dominant to non-barring	Sex-linked
White skin and shank color	Dominant to yellow skin and shank color	Autosomal
Rose comb	Dominant to single comb	Autosomal
Side sprigs	Dominant to normal comb	Autosomal
Feathered shanks	Dominant to non-feathered shanks	Autosomal
Rumplessness	Dominant to normal condition	Autosomal
Slow feathering	Dominant to rapid feathering	Sex-linked
Broodiness	Dominant to non-broodiness	Sex-linked

colored breed, the F_1 generation will all be white with the exception of a few feathers which will be splashed with color. The dominance of white in the Leghorn is due to the presence of a gene which inhibits the development of colors; otherwise the bird would be colored. The determination of the inheritance of some characters is slow because many genes are involved. Differences in egg production, egg size, body size, and ability to survive, depend on so many genes that their number has not been determined. Also, the development of the characters may be influenced by feeding, management practices, environment, and hormones. For example, a bird may have inherited the genes for high egg production but may not lay well because of unsanitary conditions and disease.

be made with birds which are pure for the dominant gene. The impurity is discovered when two impure individuals are mated. For example, if single-comb birds appear in a flock of White Wyandottes it indicates a single-comb impurity, as Wyandottes have rose combs. The birds that have single combs should be culled, for they are homozygous for this character, as rose comb is dominant to single comb. Some of the rose-comb birds in the flock will be pure for this character and some will not. The test for impurity is made by mating each bird with a pure single-comb bird. If no single-comb chicks appear, the rose-comb bird is pure for this character.

The general rule for testing the genetic constitution of a bird is to mate it with a bird that carries the pure recessive character. The individual is pure for the dominant character, if none of the offspring show the recessive character.

Inbreeding. Inbreeding is the mating of related birds to fix some desirable quality or character. Close inbreeding is the mating of closely related birds, such as brother to sister or sire to daughter. Inbreeding is one of the most discussed subjects in the whole field of genetics. All sorts of bad results have been charged to it. Close inbreeding is likely to be followed by lowered hatchability. This is the first and most important effect of close inbreeding and apparently occurs in most cases where closely related birds are mated together for more than one year. Continued close inbreeding for several generations may also result in lowered fertility, increased mortality, slower growth and later maturity.

Nevertheless, inbreeding has advantages which the experienced and skillful breeder can afford to consider. It is one of the quickest ways of fixing and intensifying characters. This at once makes it a dangerous system to use unless great care is exercised in selecting the birds to be mated, for the bad as well as the good characters may be intensified. Inbreeding is like any high-powered implement; when properly used, it is

an excellent aid to human effort, but in the hands of the ignorant and careless it is a source of danger.

Line-breeding. Line-breeding is systematic inbreeding. It involves the repetition of certain desirable individuals and their offspring in successive generations for the production of inbred strains. By this method a male may be mated to his daughters and then later to the female offspring resulting from the mating with his daughters. Similarly, a female may be mated to her son and later to a male produced from the mating with her son. The system aims to reduce the dangers arising from the promiscuous mating of closely related individuals. The success of line-breeding depends on the skill of the breeder in making his selections, and his knowledge of the laws of breeding. Line-breeding, if properly conducted, makes it possible for a breeder to develop several families of birds within the same flock which are similar in breeding and of common ancestors but not closely related. By such a plan a strain can be established without using any outside blood for several years, unless the flock is small.

Even in such matings, detrimental effects may be produced in some cases. But if the stock is vigorous and has previously been selected for desirable characters associated with hatchability, growth, and viability, successful matings may be expected.

Crossing and grading. Out-crossing is the mating together of individuals of two different strains or families of the same breed or variety. It is the opposite of inbreeding. This is done for new blood, usually, to improve the vigor, to correct some outstanding defect which the breeder has not been able to overcome, or to introduce some desirable factor which is not present in the stock. When new blood is introduced, the effect on the offspring should be noted carefully to see whether the results are what are desired. It is never advisable to use new blood extensively without first trying it in a small way to

see if it produces the results expected of it. Out-crossing should not be regularly practiced, as it tends to break down and scatter the definite blood lines established by years of line-breeding.

Grading is the mating of a mixed flock with a pure-bred male, and is the method commonly followed to improve a mongrel flock. The offspring of such a mating are called *grades* because they come from a pure-bred sire and common stock. The first cross generally shows marked improvement over the native stock. If the females of this mating are again bred to a male of the same breed, greater uniformity of type results. The continual use of males of the same breed results in a flock which is practically pure-bred. Improvement by grading is slow and tedious. Much quicker and better results may be obtained at very little extra cost by purchasing hatching eggs or a few pure-bred birds from a well-bred flock. It is well to remember that the production of eggs is an inherited quality, and that breeding for egg production is just as important among pure-bred birds as breeding for type of body or color of plumage.

Crossbreeding is the breeding together of individuals of different breed or varieties. It usually results in better hatchability, livability and growth rate of chicks. Its influence on egg production and livability of the laying flock is variable. Two separate breeds must be maintained for the production of crossbred stock. The advantages and disadvantages of crossbreeding are given on page 371.

XIX. Poultry Diseases

DISEASE is one of the most serious causes for failure in poultry-keeping. Under modern conditions, when large numbers of chickens are often raised continuously on small areas of land, the likelihood of contracting disease is greatly increased unless proper sanitary measures are followed. Unfortunately, due probably to the rapid growth of the industry and the small value of each unit, the cause and control of many poultry diseases still remains incomplete. It is generally conceded that the best method of control is by prevention rather than by cure. Some knowledge of diagnosing, preventing, and controlling a few of the most common diseases and parasites may be of assistance.

CONDITIONS THAT ENCOURAGE DISEASE, AND HOW TO PREVENT THEM

Disease is encouraged by unsanitary surroundings, improper food, poor ventilation, or internal or external parasites. Poultry or animals cannot live long in their own filth without endangering their health.

Many diseases are caused by minute living cells called microbes. They are so tiny that it requires a very powerful microscope to see them.

Bacteria have no way of traveling from one place to another except when carried. Because they are so small they are easily carried from place to place by floating particles of dust or moisture in the air, and also by man, feed, crates, equipment, insects and animals.

Bacteria require heat, moisture and food for growth. The temperature at which they will live varies with the kind of bacteria, but ranges from below zero to the boiling point of

water. They do not increase in number at very high or low temperatures, but they grow and multiply rapidly under the proper conditions. Likely places for bacteria to accumulate are in the poultry-house, yard, incubator, incubator room and brooder-house, where there is more or less filth.

Besides the harmful bacteria, many other disease-producing organisms may be present in the droppings of sick birds, and these organisms will be a menace to the health of the flock unless removed or destroyed. Likewise, worm eggs and protozoan parasites, such as coccidia, may be continually passed off in large numbers, and, as in the case of bacteria, unless removed or destroyed may find their way into the intestinal tract of healthy birds. Lice and mites should also be considered in the control of disease, as large numbers of these external parasites lower the vitality of birds, thus making them an easy prey to disease.

Bacteria and other disease-producing organisms are killed both by chemical and by physical means. The physical factors that help to destroy bacteria are drying, sunlight, and extremes of temperature. Many disease-producing bacteria soon die if merely deprived of moisture, while other kinds can withstand drying for long periods. Exposure to direct sunlight is an important way to kill bacteria, for sufficient exposure will destroy the most resistant types.

The use of disinfectants. Many chemicals are used to destroy bacteria. Of those mixed with water to form solutions, cresol preparations are the most common, inexpensive, and efficient.

Liquor cresolis saponatus is practically identical to lysol and various other soapy preparations. It is made with cresol U. S. P., linseed oil, potassium hydroxide, sodium hydroxide, and water. This disinfectant is higher priced than other cresol preparations and ordinarily is not used on poultry farms.

A number of products on the market carry trade names. These may be identical with liquor cresolis saponatus, or they may carry a cresol less refined. Some of the more carefully

made compounds will give nearly a clear solution when diluted with water. The cheaper compounds make milky solutions when mixed with water. These are efficient and cheap enough for general disinfection. A 2- or 3-per-cent solution in water, preferably hot, is recommended. Such a solution is made by mixing 3 ounces of the cresol preparation with 1 gallon of water. They may be used on wooden and metal equipment and on concrete floors. The value of different disinfectants, however, varies greatly and a poultryman has no way to judge the germicidal effectiveness of a product except by knowing its "phenol coefficient." The phenol standard for all disinfectants is carbolic acid. It is possible to secure a rating on all disinfectants from the United States Bureau of Animal Industry.

Some good disinfectants are objectionable because they are dangerous poisons to man and animals, or because contact with them results in injury to the operator or to the metal equipment used.

Bacteria are also destroyed by certain gases, the most common of which are formaldehyde and sulfur. Formaldehyde gas is generated by combining 20 ounces of 40 per cent solution of formalin with 10 ounces of potassium permanganate, mixed in an earthenware bowl. This is sufficient to disinfect 1,000 cubic feet of room space, provided the cracks and crevices around windows and doors have been properly blocked to retain the gas. The fumigation should last for at least one-half hour. To obtain the cubic capacity of a room, multiply the length by the width and this sum by the height. Thus a room 20′ x 16′ x 10′ will have a cubic capacity of 3,210 cubic feet. The correct dosage for this room is figured as follows: $3{,}210 \div 1{,}000 = 3.21$ cubic feet. $3.21 \times 20 = 64.2$ ounces of formalin and $3.21 \times 10 = 32.1$ ounces of potassium permanganate. The gas is much more efficient if the air in the room is warm and well saturated with moisture. The room should be dry-cleaned previous to fumigation as this gas does not penetrate deeply into materials. Table XLIV gives a list of the more common

disinfectants, the proper strength of solution and their uses.

It should be borne in mind that such forms of organisms as coccidiosis and worm eggs, which are unusually resistant, will not be destroyed by the disinfectants mentioned. Special ways of dealing with these are given under their respective headings.

Cleaning a poultry-house. The poultry-house should be thoroughly cleaned before using a disinfectant. All roosts, feeders and movable equipment should be taken out. Then sweep down all dust and cobwebs, wash the windows and clean the floor by scraping off all dried material. After sweeping, scrub the floors and about one foot of the adjoining walls with a hot lye solution (6 ounces of lye in 12 quarts of water). Apply this solution with a stiff broom. After the floor is dry some disinfectant should be used. A coat of whitewash applied to the ceiling and side walls is not only a good disinfectant, but improves the appearance of the interior. After the poultry-house has been disinfected, the interior fixtures can be returned to their places as soon as they have been properly cleaned and disinfected. It is well to remember that the use of disinfectants will not take the place of cleaning. Without this, the action of the disinfectants may be neutralized or rendered useless by union with organic material. It is a loss of time and material, therefore, to apply a disinfectant to a surface that has not been thoroughly cleaned previously. The apparatus for disinfecting does not need to be expensive. Some form of hand-sprayer or pump is best, as the disinfectants can then be forced easily and quickly into every crack and corner.

Sanitary precautions. Much can be done to control losses from disease on poultry-farms by simple precautionary methods. Disease is very often introduced into a flock by new stock. This is more likely to happen with grown birds than with chicks and consequently it is safer when purchasing new breeding stock to buy hatching eggs or day-old chicks. Birds returned from a poultry show or an egg-laying contest where

TABLE XLIV

THE USE OF COMMON DISINFECTANTS

DISINFECTANT	STRENGTH USED	PURPOSE	USE
Argyrol	10 to 15 per cent solution	Mouth, nasal cavity, wounds, vent	Not a general disinfectant
Lime (*unslaked*)	Sprinkled on soil	Poultry runs, filthy puddles, manure	If necessary, sprinkle with water after placing on soil. Keep fowls off run for 1 week
Carbolic acid (*crude*)	5 per cent (*1 pt. to 10 qts. of water*)	Interior of houses, in whitewash, wounds, incubators	Good general disinfectant
Calcium hypochloride solution (*home made**)	Use 2 tablespoonfuls to each gallon of drinking water	Drinking water	Not a general disinfectant. Do not hold stock solution more than 10 days
Iodine	Tincture	Wounds	Never use as a general disinfectant. Keep away from metal
Formaldehyde gas	20 oz. formalin 10 oz. potassium permanganate for 1,000 cubic feet	Interior of poultry-houses, incubator room sectional incubators	Tight house, temp. 60° F. or above, sufficient moisture
	40 c.c. formalin, 20 grams potassium permanganate to 100 cubic feet	Forced-draft incubators	99° F. to 100° F. temperature, 90 degrees wet-bulb reading
Cresol compound solution (*Liquor Cresolis Saponatus*)	3 to 5 per cent solution, (*½ pt. to 8 qts. of water*)	Interior poultry-houses, incubators	Good general disinfectant
Potassium permanganate	1–500 to 1–1,000. (*1 gram to 1 gal. water —amount that will stay on 5 cent piece*)	Drinking water, wounds	Never used as a general disinfectant. Best used in earthenware vessels
Whitewash	Slack 4 lbs. lime with 1 qt. water and dilute to proper consistency	Interior of poultry-houses	Use freshly prepared

* To make, take one 13-ounce can of chloride of lime, ½ pound of fine table salt and 1 gallon of hot water. Mix until dissolved; allow lime and salt to settle and use only clear liquid. Prepare the mixture in earthenware or glass jars and keep protected from the light.

they may have come in contact with diseased birds, as well as new breeding stock, should be kept in separate pens for at least two weeks before they are placed with other stock. Infection may also be carried on to the premises by wild birds, dust-laden wind, insects, rats, mice, shipping crates, feed-bags, attendants or visitors. On all poultry farms it is advisable to screen open windows with a 1-inch-mesh wire to keep out sparrows.

Anything about the premises that calls flies or provides suitable breeding conditions for them is a menace. The dropping boards should therefore be cleaned often, and the cleanings, as well as the dirty litter, carried a long distance away from the houses before spreading on the land, or placed immediately in a screened manure shed. The carcasses of dead birds should be burned or buried (Fig. 164). Wet spots, especially around the drinking vessels in the yards, should be avoided. In warm weather such moist places are fine incubators for worm eggs and disease organisms. One way to prevent this is to place all drinking vessels on screened platforms over shallow pits (Fig. 165). Where the adult stock is given free range, a double-yard system should be used. The poultryman should rear each year's crop of chickens on clean land (where poultry has not ranged or manure been spread for at least two years) and in this way leave the previous year's troubles behind. In some cases screened wire or concrete platforms have been used to overcome a very bad outbreak of worms or disease, but this method should be used only as a last resort.

Fig. 164. A crematory.

Many diseases, such as tuberculosis, blackhead, fowl typhoid, cholera, coccidiosis and internal parasites are commonly spread through the droppings. The usual practice of throwing scratch grain on the floor to give the birds exercise is objectionable because worm eggs and disease-producing organisms may be taken in with the food. By following the hopper method of feeding grain and mash to both young and old stock, much of the danger is avoided, as little if any droppings come in contact with the feed and water if the hoppers and drinking vessels are so arranged as to keep the birds from

walking or roosting on them. Figs. 37, and 76 show such feeders for old and young stock. At the Pennsylvania Experiment Station a comparison of floor and hopper feeding of chickens showed 60 per cent less loss from coccidiosis when the hopper method was used. The infection in this experiment was introduced by adding five artificially inoculated chicks to flocks of twenty healthy ones.

Fig. 165. A sanitary range drinking platform and cover.

Finally, the ventilation of poultry-houses should be considered in the control of disease, for improper or inadequate ventilation is often responsible for colds and roup. It is necessary to have an adequate supply of fresh air, without drafts, at all times.

DIAGNOSIS OF DISEASES

When chickens are sick, the owner is immediately interested in finding out what has brought on the condition, and what should be done to cure or prevent it. A diagnosis or study of the external symptoms is first necessary; afterward a post-mortem examination may be advisable. The farmer seldom has facilities or the training to do this and, when necessary, should turn such work over to a trained veterinarian or state laboratory.

How to make an external examination. When examining the external symptoms of sick birds, the following points should be taken into consideration:

1. Appearance of the head. No part of the chicken's body reflects its condition more promptly than the head. The size, color and feel of the comb and wattles; the brightness and color together with the prominence or sunken condition of the eyes; the size, shape and

fleshing of the skull, and the position and condition of the feathers, help in diagnosing a diseased condition. Every poultry-keeper should know what a healthy bird's head looks like, as compared with one that is not.

2. Condition of flesh. Loss of flesh or condition is an important symptom.
3. Condition of the plumage. Sick birds usually show a ruffled or mussy condition of the feathers. This may not be true of all diseases, but it is for most of them. It is always well to look for lice and other external parasites with this condition, if nothing more.
4. Condition of the skin. The scales on the legs and feet and the body skin should be examined for any unusual condition.
5. Deformities and injuries. The bird should be examined for an abnormal condition of the body or possible infection such as sores, canker, frost-bite, injuries and the like.
6. Note the condition of the bowels. Many poultry diseases affect the bowels in one way or another, but most often by causing a diarrhea.

How to make a post-mortem examination. Find a table, barrel or box of convenient height and locate it either out-of-doors or in a room where there is good light. Secure a small sharp scalpel or pocket-knife with a slender blade. Spread a newspaper on the table, then place the dead bird on it with the back down and the feet toward the operator. Grip the end of the keel-bone with the left hand, and, with the right, cut the skin and flesh on the body from the thigh on the right side around just above the vent to the thigh on the left side. Peel back the skin over the breast-bone to the crop. Break down the leg-bones at the hips so that they will lay flat on the table and will be out of the way. Hold the keel-bone firmly with the left hand and then break the back downward with the right hand. This will expose all the internal organs. Carefully tear or cut the tissues which hold the intestines in position and spread them out near the body. If necessary, the head can be split lengthwise by placing a butcher-knife on it and striking the knife once or twice with a hammer.

Examine the vital organs systematically. Begin with the liver, spleen and gall-bladder because they are close together. When perfectly healthy, the liver will be a rich chocolate-brown color free from white or grayish spots or lumps, and firm to the touch. The spleen is similar in color and texture to the liver, but is much smaller. The gall-duct, dark green in color, is attached to the liver and is about 1/4 inch in diameter.

Next examine the lungs and heart located near the front of the body. Healthy lungs have a light red color.

After looking at the crop, proventriculus or stomach and gizzard, the ovaries, oviduct and kidneys are inspected. The kidneys are imbedded in the back of the bird toward the rear of the carcass and are similar in color and texture to the liver.

Lastly, the intestine and caeca (two blind pouches) are opened full length for evidences of worms or inflammation. The normal color of the intestines is light gray. They should be free from wrinkles or nodules. To get the most out of an autopsy, the operator should be familiar with the appearance and condition of the organs in a healthy bird.

A post-mortem examination takes only a few minutes and is a valuable supplement to the external examination in arriving at a correct diagnosis of disease.

ASPERGILLOSIS (BROODER PNEUMONIA)

This is a disease of the respiratory system caused by a fungus growth which develops in the membranes of the nostrils, mouth and throat, finally affecting the lungs and other organs. The name of the fungus is *Aspergillus fumigatus*, or common green mold. It is inhaled by birds when scratching in moldy litter or eating moldy feed. The warmth and moisture of the inside linings and membranes of the bird's body provide an extremely favorable environment for the development of the spores of this fungus, while its virulence makes it difficult for the animal tissue to overcome and dislodge. It causes heavy losses in chicks as well as mature fowls.

Aspergillosis may affect individuals, or a large number of birds in a flock. At first the breathing becomes more rapid. Later, as the irritation increases, there is a rattling or croupy sound when the bird exhales and slight catarrh. The affected birds are weak, mopy and remain in a sitting position by themselves with drooping wings. Toward the end, they shake and gasp for breath. A post-mortem examination often reveals small white or brown nodules in the air-sacs. Flat slightly greenish spots are sometimes seen on the bronchial tubes, lungs and other internal organs.

Young chicks die within a few days but older birds may live for two or three weeks after the symptoms first appear.

There is no very satisfactory treatment. The litter and feed should be examined carefully, and promptly changed if necessary. The carcasses of affected birds should be burned or buried.

Aspergillosis can be prevented by always using clean wholesome feeds, bright clean litter, and proper sanitary precautions.

BLACKHEAD

Blackhead or entero-hepatitis is caused by a minute protozoan parasite. It is a highly fatal disease of turkeys and may affect chickens, grouse, and peafowl. Many recovered turkeys and chickens act as carriers of the disease and spread it to other birds through the droppings. The disease can also be carried in the eggs of cecal worms which may be picked up with the feed. Infection may occur from other means, however.

Blackhead usually appears in chickens when they are from 5 to 10 weeks of age. In turkeys it occurs at all ages, but principally during the period from 6 to 14 weeks.

The disease makes its appearance rather suddenly in chickens and then disappears. With turkeys it produces a lingering illness with the mortality extending over quite a period.

Chicks affected with blackhead are inactive, droopy and

sleepy. They pass droppings tinged with blood. Death follows shortly after the first symptoms.

Affected turkeys are similarly inactive and do not eat. They become thin and walk with a stilted gait. The head may become a bluish black in color. Diarrhea with watery yellowish droppings may be seen. Several days may elapse following these symptoms before the birds die.

Examination of the internal organs usually shows the ceca and liver to be involved. The cecal walls are ulcerated and thickened and usually are filled with a reddish-yellow core of cheesy material. The liver is enlarged, darker than normal and studded with sunken reddish gray areas of various sizes.

The treatment of blackhead in chickens is the same as for acute coccidiosis. This disease has not been serious with chickens as they acquire immunity to it quite rapidly.

No medical treatment for turkeys has been found satisfactory. Control is largely through proper rearing methods. (See Chapter XX.)

BOTULISM (LIMBERNECK)

Botulism, or food poisoning, is a disease caused by the toxins of a microorganism that is common in spoiled food or grain. Outbreaks have been traced to feeding spoiled canned food, decomposed meat or vegetables. The germs of botulism are widely distributed in soils and possess highly resistant spores. From contaminated soils the spores may gain entrance to grains, decaying animal or vegetable material in which they multiply and produce a powerful poison.

The botulism organism differs from other disease-producing organisms since it does not multiply in the body but in feeds. Maggots that feed on contaminated carcasses may become highly poisonous and poison chickens that eat them.

Heavy losses have occurred in some of the western states when wild ducks consumed decomposed vegetable material in swamps and on the bottom of shallow stagnant pools.

Chickens and ducks are most frequently attacked. Symptoms appear soon after the poison is eaten. The birds will recover if small amounts are eaten but large amounts are fatal. Affected birds may spread the disease by their droppings. The carcasses of birds dying of botulism are also a source of danger.

In mild cases of botulism there is leg weakness and drowsiness but this soon disappears. Affected birds recover in two or three days.

In more severe cases there is sleepiness and the neck muscles become paralyzed, causing the head and wings to rest on the ground. Fatally affected birds lie outstretched in a state of coma and are seemingly lifeless for several hours before they die. The internal organs appear normal on post-mortem examination.

A sudden appearance of several cases of typical botulism in a flock is usually the first indication of the disease.

Control consists, first of all, in looking for the contaminated food and removing it. Dead birds should be burned and the houses thoroughly cleaned. The sick birds should be removed to a comfortable pen where they may be given a physic, such as a teaspoonful of epsom salts in half a glass of water or two teaspoonfuls of castor oil to each fowl. Epsom salts may be given as a flock treatment at the rate of one pound in the drinking water of 100 birds.

INFECTIOUS BRONCHITIS

Infectious bronchitis, sometimes called chick bronchitis, is caused by a filterable virus which affects the respiratory organs of chicks and adult birds. The disease is much more serious with chicks than hens, often causing serious losses. There is seldom any mortality among the older birds, although egg production is usually affected. Recovery from the attack results in immunity.

Affected chicks gasp, cough, and have a rattling noise in the

throat. There may be a nasal discharge and inflammation about the eyes. Although the symptoms are similar to laryngotracheitis in fowls there is no expulsion of bloody mucus.

Post-mortem examination usually shows the bronchi and trachea to be inflamed and filled with mucus or cheesy material.

Treatment is not successful. Dusts or sprays may give some temporary relief but will not stop the course of the disease. The birds that recover, although immune, may act as carriers to other stock.

Two methods of control are suggested: one consists of disposing of the entire flock, followed by thorough cleaning of the housing facilities and equipment; the other is to move the affected chickens to another farm at least half a mile away where they should be handled as though they were on a separate poultry farm. The caretaker of this flock should keep away from all other stock.

After the chickens have recovered, stunted birds should be culled, but those remaining should still be kept by themselves.

Prevention of the disease is through strict sanitation in the operation of the incubating equipment. The source of the disease is unknown but the causative organism is probably carried into the hatchery on egg shells or egg cases, or in other ways from infected stock. If the incubators and eggs are fumigated between hatches, it will prevent the spread of the disease in the incubator.

When there is an outbreak in the hatchery room it will be necessary to fumigate the room as well as the incubators. (For directions on how to fumigate see Chapter VII, page 119.) Previous to fumigation all chicks should be removed and properly disposed of.

COCCIDIOSIS

Coccidiosis is one of the most common and serious diseases of chickens.

This disease occurs in chickens from three weeks of age to maturity, but the acute form is especially destructive to young chickens from four to twelve weeks of age. Coccidiosis is caused by a microscopic protozoan parasite which attacks the lining of the intestines. There are eight species of coccidia which affect chickens. One species, *Eimeria tenella,* causes the cecal or acute form of coccidiosis, while the others cause the intestinal or the chronic form of the disease. The different species of coccidia are so closely related that in the prevention and control of the disease they may be considered as one.

THE LIFE STORY OF COCCIDIOSIS

In studying ways and means of fighting any disease the first step is to find out how it develops, and what conditions stimulate or retard this development. The life history of the coccidiosis organism is quite complicated but only the most important parts need be considered. The parasite is taken in with the food and water. Both are easily contaminated. The organism passes through a number of stages in the intestinal lining and eventually forms a spore which is known by scientists as an oöcyst. These oöcysts are resistant to ordinary disinfectants and outdoor conditions. Chickens affected with coccidiosis throw off large numbers of oöcysts in the droppings. At the time the oöcysts leave the bird's body they are harmless or non-infective, but with proper moisture and temperature they soon develop to the infective stage. With moisture and a temperature of about 70° F. development may take place in from one to three days. Where moisture and temperature conditions are less favorable, the oöcysts will not develop but remain dormant in the soil for several months. Continued exposure to the sunlight, decomposition and dryness, however, destroy the oöcysts. High temperatures and dryness are particularly destructive to the oöcysts.

Recent work at the New York State Veterinary College has shown that coccidiosis can be transmitted by a stage of the

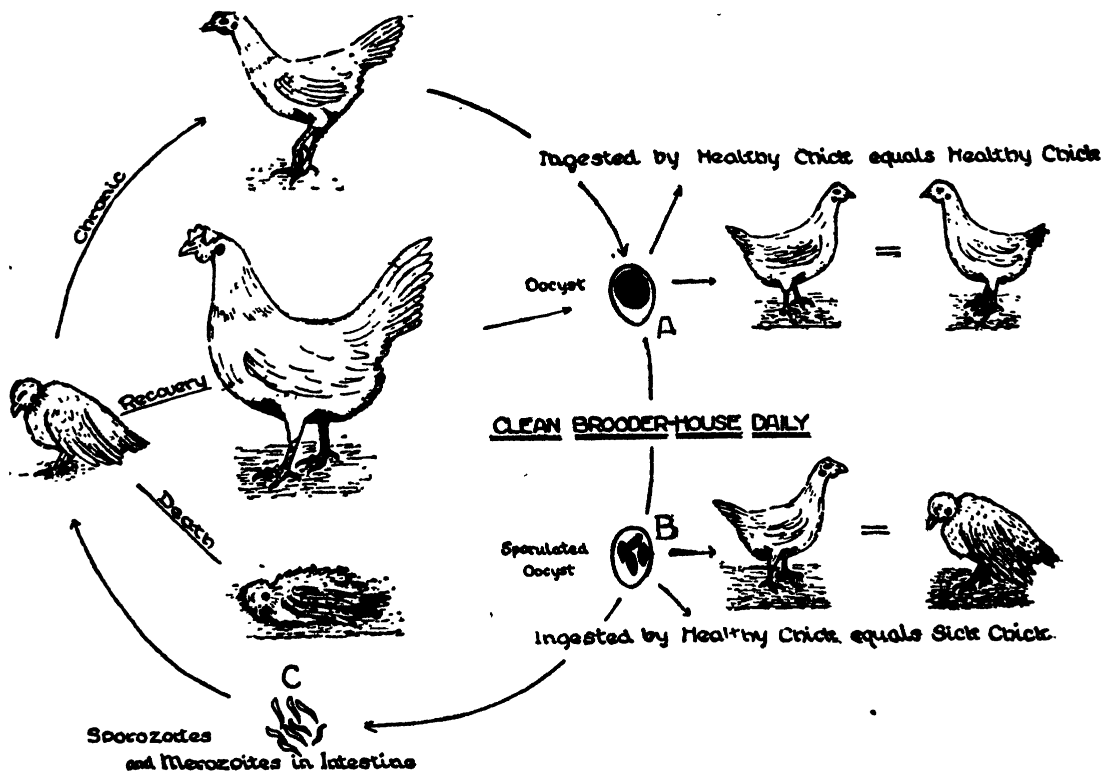


Fig. 166. Cycle of infection with coccidiosi..

coccidial organism other than the sporulated oöcyst which was formerly considered the only stage of infection. Microscopic banana shaped bodies called merozoites are produced during the process of developing the oöcysts in the chicken's intestines. These merozoites invade the cells lining the intestine where they grow and multiply and, at the same time, cause great damage. Besides those that penetrate the intestinal walls, great numbers are thrown off in the droppings. These merozoites, if taken with the food soon after they are discharged in the droppings, will infect susceptible chickens. All types of

Fig. 167. Seven-weeks-old chicks affected with coccidiosis. (New York State Vet. College.)

coccidia except the cecal type can be transmitted in this way. However, there is no doubt that ingestion of sporulated oöcysts is still the chief means of the spread of coccidiosis among chickens.

Work carried on by the New York State Veterinary College at Cornell University during 1932, shows that the *Eimeria tenella* oöcysts will remain alive in the soil for at least five months even under freezing conditions. It was also found that heavy applications of slacked lime mixed with the soil was not

effective in destroying coccidia. Oöcysts on the surface of the soil were killed in a few days by direct exposure to sunlight, but those underneath the surface and in shady places, where there was moisture, remained alive for the duration of the test.

The data indicate that a wooded or swampy range harbors coccidiosis organisms longer, and from a disease prevention standpoint are not as desirable as open, well drained land with a moderate amount of shade.

The severity of an outbreak of coccidiosis depends not only on the numbers of oöcysts consumed within a certain period of time, but their continued introduction into the body at a high rate for a long period. A certain amount of immunity or resistance is set up when the birds are exposed to small doses of the coccidiosis organism. Trouble begins when they have an overdose. The problem of the poultry-keeper is to keep the dosage within certain reasonable bounds by a program of sanitation and management.

Sporulated and nonsporulated oöcysts are quite resistant to unfavorable surroundings because of their protective shell.

Several investigators have shown that coccidiosis organisms are particularly resistant to practically all disinfectants [1] as they are commonly used, unless they remain in contact with them for a considerable time.

Severe outbreaks of coccidiosis are more likely to occur in flocks of growing chickens weakened by improper feeding, housing and brooding. The disease is most commonly picked up in some way from adult birds that harbor the germ, or by running on soil previously contaminated by diseased chickens, or from land on which droppings from diseased birds have been spread. The infection may also be carried from one place to another on the shoes or clothing of the attendant, by wild birds, dust-laden wind, utensils for cleaning, visitors, and in

[1] Iodine suspensoid, an iodine preparation developed by Chandler of the Mich. Agr. Exp. Sta., is said to be effective in destroying coccidiosis organisms.

other similar ways. It is not likely that infected hens ever transmit the disease to chicks through the egg. Although coccidia may appear on the shells of hatching eggs, it is not likely that they will survive the incubation period at incubation temperatures.

Coccidiosis appears in two forms: the acute type which is particularly serious in young chicks; and the chronic form which makes its first appearance in the growing flock usually during the last few weeks on range or soon after the birds are housed. The acute form is usually present in the ceca (blind pouches) while the chronic form is confined to the small intestine, particularly in the duodenal loop. In some cases the chronic form may be seen before the chickens are eight weeks old.

ACUTE COCCIDIOSIS

External symptoms. The first indication of an outbreak of acute coccidiosis in a flock is droopiness of a few chickens. The affected birds remain close to the hover or in groups in the sunshine. They do not eat and they stand with wings drooping, head drawn in, and eyes closed for long periods unless disturbed. This droopy condition may continue for two or three days before death occurs.

During the early stages of the attack there is usually a watery diarrhea, frequently tinged with blood, which wets all the feathers near the vent.

Internal symptoms. Examination of the intestines often shows the ceca to contain blood in a clotted or fluid form.

When an outbreak of acute coccidiosis occurs, the flock should be given the sulfur treatment or flushed with a milk-mash mixture. "The milk mash is prepared by adding 40 pounds of dried skimmilk to 60 pounds of starting or growing mash. Scratch feed is withheld until the end of the treatment. Plenty of water is provided, and the litter should be kept dry by frequently changing or fresh litter should be placed in the

pen. The milk-mash mixture is fed from three to five days continuously; never longer without a return to the regular mash for a few days. At the end of the treatment, the litter is

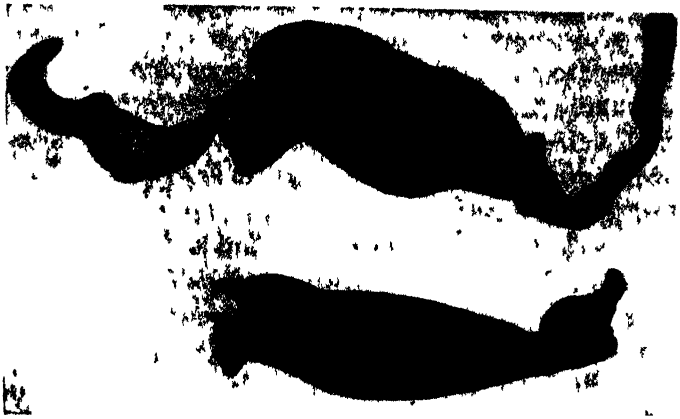


Fig. 168. Above, caecum of chick affected with coccidiosis. Below, normal caecum. (N Y. State Vet. College.)

changed. Disinfection of the pen is not needed unless conditions are very bad. Moving the brooder houses to another part of the range is always desirable if the birds are on range. Dead chicks should be burned or buried deeply."[2]

Flowers of sulfur may be mixed with the mash in the proportion of 5 pounds of sulfur to 100 pounds of starting or growing mash. No scratch grain is fed. The sulfur is fed for one week. Unless the birds run out-of-doors daily, or are exposed to the sun's rays, it is not safe to feed sulfur longer than one week, as the sulfur neutralizes the vitamin D supplement in the ration. Continuous feeding of sulfur to laying pullets behind glass windows at the Wisconsin Experiment Station when cod liver oil was fed to supply vitamin D, resulted in egg paralysis, poor egg shell texture, marked reduction in hatchability, and a high percentage of fetal rickets.

It is well to remember also that the feeding of sulfur is more

[2] Dr. E. L. Brunett, Cornell Extension Bul. 337, p. 36.

of a preventive than a cure of coccidiosis. It will not check the disease among those that already have it, but will prevent uninfected chickens from contracting the disease as long as it is fed. The preventive value of sulfur ceases twenty-four hours after it is discontinued. This treatment is intended only to aid poultrymen to gain time to carry out proper sanitary measures.

The sulfur treatment has a beneficial effect on chickens infected with massive doses of *Eimeria necatrix*, one of the severe intestinal types of coccidiosis in older birds.

Most drugs recommended for the control of both acute and chronic coccidiosis have been of little value.

"Studies on the remedial value of sulfanilamide, sulfapyridine, sulfathiazole, and sulfaguanidine for coccidial infections have been carried on at this college (N. Y. State Vet. College). Some of these have value for one type and others for others. In general, the cost of such treatments is excessive, which prevents their general use. The 'sulfa' drugs may some day play an important part in the control of these infections." [3]

CHRONIC COCCIDIOSIS

Chronic coccidiosis develops slowly, affecting only a few birds at a time, but it often results in heavy mortality up to and following maturity. Sometimes the best laying pullets in the flock are attacked.

External symptoms. There is loss of appetite, dirty roughened plumage, gradual loss of flesh, paleness of comb and wattles, and sluggish, weak movements in walking.

Internal symptoms. Examination of the first one or two feet of the small intestine next to the gizzard usually shows it to be greatly "bloodshot." It is frequently impossible to be sure that the bird has coccidiosis without the use of a microscope.

Death from chronic coccidiosis is prolonged and may come after several days or even weeks of sickness. As the bird becomes weaker, its chances of obtaining the proper amount of

[3] Dr. E. L. Brunett, Cornell Extension Bul. 337, 1942.

food are reduced and often as a result the bird dies of starvation.

The control of the chronic or intestinal coccidiosis is almost entirely by preventive measures in rearing the young stock. The milk treatment does not give satisfactory results and no known drugs are effective. The sulfur treatment already mentioned may be helpful, especially for the *Eimeria necatrix* form of the disease.

In carrying out a preventive program it is well to remember that the chief source of coccidiosis infection is the old birds that harbor the disease.

Most birds can overcome small doses of coccidia, but when the intake becomes excessive the parasite may overcome the resistance of the birds. Massive infections should be avoided by careful brooding and sanitation. A program of disease control is given in Chapter IX, page 177.

EPIDEMIC TREMORS

Epidemic tremors or avian encephalomyelitis is a disease affecting the nervous system of chickens. Since its discovery in Massachusetts in 1932, it has slowly spread to other parts of the United States.

The disease is caused by a specific virus which appears primarily during the first five weeks of the life of the chick.

The first symptoms are constant trembling of the head or weakness of the legs or both. The trembling becomes more pronounced upon handling of the chicks, but subsides when the chicks are left alone and may disappear when they are asleep. The degree of trembling varies. Birds showing just the trembling may live and reach maturity.

Ataxia or weakness of the legs in many cases develops before any trembling is noticed. This form of the disease is much more serious than the trembling as it handicaps the bird in moving around and in securing sufficient feed to live. In the later stages there is complete paralysis of the legs. These

chicks eventually die. Mortality may reach 60 per cent in some flocks.

This disease seems to attack cross breeds more frequently than pure breeds. An epidemic usually affects only one or two hatches during the season either during the late fall or from January to June; although in hatcheries the disease may extend over several hatches.

The exact method of transmission of epidemic tremors is unknown, but it is suspected that it is transmitted through the egg.

The diagnosis of this disease is made by the characteristic clinical symptoms and the microscopic lesions found in the brain or spinal cord.

No treatment or control measures are available. Visibly affected chicks should be culled, but condemnation of affected parent stock should be contemplated only after repeated outbreaks.

FAVUS (WHITE COMB)

Favus is a contagious disease of the skin caused by a fungus. It first appears, as a rule, in the form of grayish-white

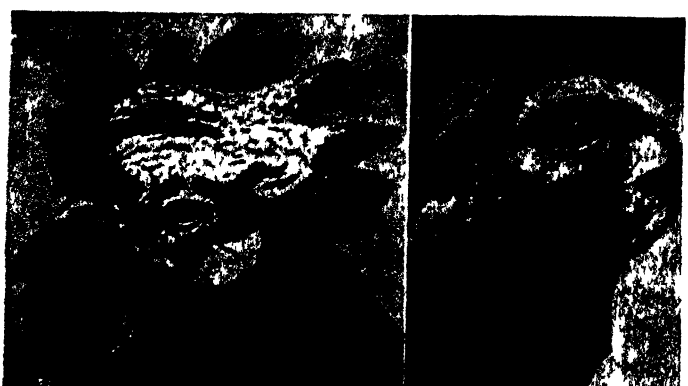


Fig. 169. Left, favus or white comb (after Sabouraud). Right, hen affected with coryza.

spots on the comb, earlobe or wattles, but may attack the feathered parts of the skin. The tiny white or grayish spots on the bare parts of the head increase in size until the whole surface of the head is covered with dry, scaly, white crusts. As the disease advances the neck and body are gradually invaded, causing the feathers to become brittle and break off easily.

All diseased birds should be isolated. If the body is affected, one should kill the bird and burn the carcass. When only the bare head parts are attacked, tincture of iodine may be applied or an ointment of formaldehyde and vaseline (one part formalin in twenty parts of vaseline). As this disease is associated with poor housing conditions and sanitation, these should be corrected. The disease may occur in a well managed flock but usually fails to spread.

FOWL CHOLERA

Fowl cholera is a highly infectious disease that may affect all species of domestic birds. Chickens and turkeys are the most common victims. Many wild birds are liable to the infection and this may be one of the ways of spreading the disease.

It is caused by a specific organism, *Pasteurella avicida,* that is found is large numbers in the blood and various organs of the body which produces septicemia or blood-poisoning. The germs of the disease are carried from one flock to another by sick or recently recovered birds introduced into a healthy flock, by persons, animals, wild birds, or by the use of utensils from an infected flock.

Fowl cholera may appear in acute or chronic form.

It is not always possible to determine how the disease is introduced into a flock. Carrier birds which outwardly show no symptoms of the disease may harbor the germs in the nasal passageways and spread the infection. Also, unsanitary conditions encourage the development of the disease in the flock.

Once introduced the disease spreads rapidly through the flock. The enormous number of germs thrown off in the drop-

pings of a few sick birds, unless they are quickly removed, is likely to contaminate the food and drink of the healthy ones, thus rapidly causing the healthy birds to become infected. In

Fig. 170. Fowl cholera. (University of Illinois.)

very acute cases there are no symptoms before death. In less acute forms a yellowish discoloration of the droppings is first noticed. This is followed by a brownish or greenish diarrhea. The comb turns purple, there is loss of appetite, feverishness with excessive thirst, heavy breathing with a foamy discharge from the beak and nostril, extreme weakness, sleepiness and an inclination to sit with the head turned backward or resting in the feathers of the wing. Just before death the bird seems stupid and lies with the beak resting on the ground. Death usually occurs in one to three days.

Post-mortem examination shows small red spots or hemorrhages on the surface of the heart, hemorrhages or small red spots on the small intestine which is somewhat swollen, enlarged liver and spleen.

Cholera may cause the death of a large percentage of a flock in a week and then disappear, or after an acute attack

it may remain for months in chronic form, killing birds occasionally.

Respiratory symptoms in the form of cold are common with chronic cholera. This is accompanied by gasping and by a swelling of the head and wattles. The symptoms are similar to those appearing with infectious coryza and should not be confused with that disease. The wattles when first swollen are soft and warm; later they become hard and cold.

Further symptoms of chronic cholera are anemia with a persistent diarrhea, weakness, emaciation and swelling of leg and wing joints, which finally ends with a breaking of the swellings and the discharge of a creamy or cheesy mass.

A post-mortem examination reveals pus in the nasal passages and sometimes in the air sacs.

Treatment of cholera-infected birds with medicines is useless. The same is true of vaccines, particularly mixed bacterins. Unaffected birds may be given an injection of autogenous bacterin, if there is time to prepare it before the disease spreads. At the beginning of an outbreak of the milder or chronic form of cholera, affected birds should be removed to a heated pen if the weather is cold. Heat helps the birds to recover. The nasal passages of birds most seriously affected may be washed out with warm water followed by a few drops of 15 per cent argyrol solution. The swollen wattles of affected birds should be cut off after the acute symptoms of the disease have subsided.

Fowl cholera is best controlled by the same preventive measures as suggested for infectious coryza and by keeping the houses and ranges in a reasonably sanitary condition.

FOWL PARALYSIS

Fowl paralysis and related leukemic diseases are one of the most serious disease problems affecting poultry. It appears in poultry flocks all over the world.

The disease is comparatively new, although Marek describes

it in an article published in a German veterinary journal in 1907. It was first recognized in the United States in 1914 and reported in 1921.

Forms of the disease. Fowl paralysis is also known variously as range paralysis, leukemia, lymphomatosis, neurolymphomatosis, etc. Strictly speaking, leg paralysis is only one phase of the disease, for there are several different types. Recently, because of its complex nature, pathologists have referred to this disease as the "avian leukosis complex."

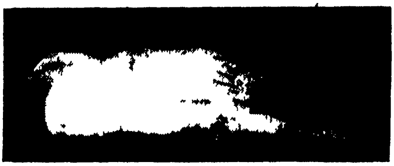


Fig. 171. Bird affected with fowl paralysis. (Poultry Dept., Cornell Univ.)

"The following forms of the disease, named after the organs or tissues most prominently affected are recognized.[4]

The nerve form (neural lymphomatosis) is characterized by paralysis of the legs, wings, or neck (Fig. 171).

The eye form. (ocular lymphomatosis) is characterized by grayness of the iris, and irregularity of the pupil (Fig. 172).

The visceral form (visceral lymphomatosis) is characterized by enlargement (tumorlike formation) of the internal organs.

The blood form (leukosis) is characterized by marked changes in the blood, including anemia.

The bone form (osteopetrosis) is characterized by thickening of the long bones, particularly the shanks."

Cause. "The cause of fowl paralysis is not definitely known. However, the disease may be transmitted artificially from bird to bird by inoculation of filtrates obtained from the organs of a diseased bird. Hence, indications are that the causative agent of this disease is a filterable virus, an extremely small organism which cannot be seen with a microscope, and which is able to pass through the finest bacteria retaining filter."

The part that such factors as diet, management, parasites,

[4] W. J. Hall, U. S. D. A. Circular No. 628, p. 4, 1942.

and heredity have in causing the disease is not clear and have not been fully investigated. The evidence thus far does not indicate that diet is important, but management in rearing and segregating the young stock and breeding may have an important bearing on the incidence of the disease.

"There are two theories concerning the causative agent or

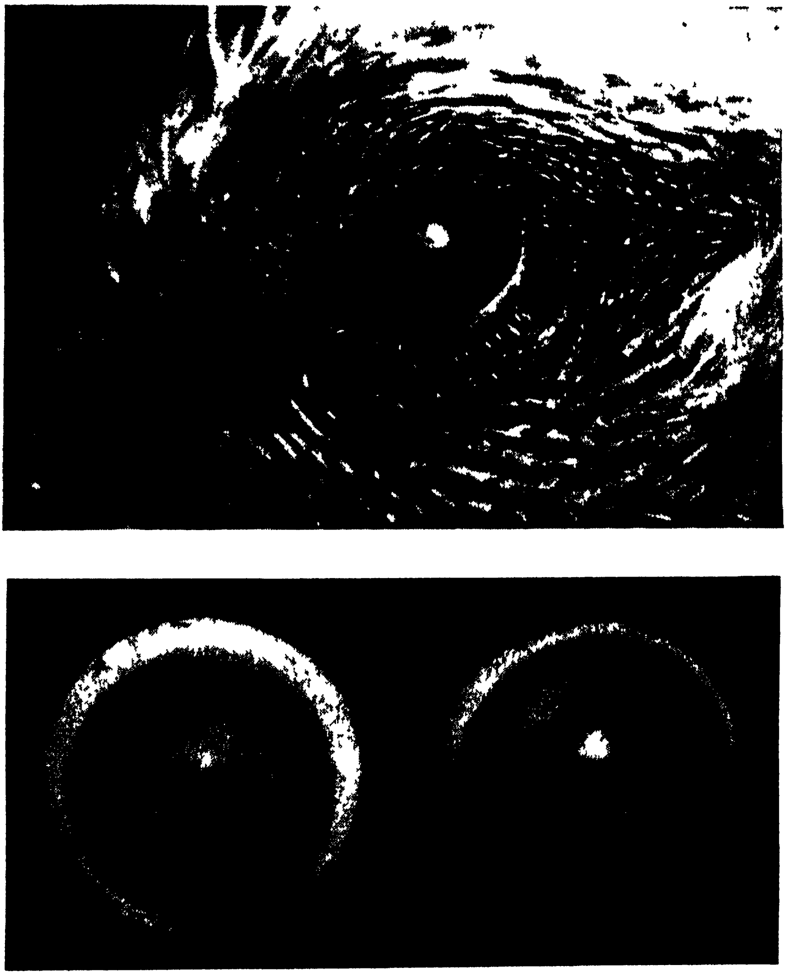


Fig. 172. Eyes affected by a form of fowl paralysis. (Poultry Dept., Cornell University.)

agents, among investigators of the disease. One is that all forms of the disease are caused by the same agent. The other school of thought believes that the different forms of the disease are caused by two or more distinct though possibly related agents or viruses. Two or more forms of the disease may be present simultaneously in a flock and may occur in several combinations. Usually, however, one form of the disease predominates in a flock."[5]

Symptoms. "In the nerve form (neural lymphomatosis) of the disease the legs, wings, or neck lose their power of movement in varying degrees. At the onset of the disease the symptoms may be slight and scarcely noticeable, such as a slight limp or weaving gait, a partial dropping of the wing, or the head may be held at an unusual angle. Later the leg or wing may lose more and more of its usefulness until the bird is unable to stand or it may drag one or both wings on the ground."

"A characteristic posture in an advanced case of paralysis is one in which the bird lies on the side of the breast with one leg extended forward and the other backward."

"In other instances wry neck may be the most prominent symptom, in which case the head may be drawn to one side, tilted upward and backward, or held down near the ground with the beak pointing up."

"Occasionally the breathing apparatus is involved causing the bird to gasp for air. This symptom may closely resemble the respiratory gasps seen in respiratory diseases but in respiratory paralysis there are no exudates and no breathing noises."

"The function of the digestive tract is frequently disturbed, especially in the prolonged cases, as evidenced by extreme loss of flesh and diarrhea or constipation. The appetite remains good and the bird will eat as long as it is able to reach food."

[5] W. J. Hall, U. S. D. A. Circular No. 628, p. 4.

"Post-mortem examination shows little or no change in acute cases other than enlargement of the nerve supplying the affected limb."

"In the eye form of the disease, the most prominent symptoms are loss of pigment from the iris, and changes in the pupil. This manifestation of the disease is often called gray eye. Grayness of the iris is caused by replacement of the normal orange or bay pigment by a type of immature, white blood cell. This fading of the iris pigment usually begins at the inner edge surrounding the pupil and gradually progresses until the iris becomes completely gray, or bluish-gray."

"Usually along with the gray iris the pupil becomes affected, either contracting to pinhead size or becoming abnormally dilated. In other cases the pupil becomes irregular, ragged or eccentric. These changes result in partial or complete loss of sight."

"In the visceral form of the disease, there may be no visible symptoms, especially if the tumors are confined to the internal organs. In cases of long standing, however, emaciation and depression may be noted, and occasionally a swollen, dropsical abdomen may be observed. If the tumors are external they may be seen on any part of the body."

Tumors may be found in any of the internal organs, but most frequently in the liver, ovary, kidneys, and spleen. These tumors are the result of proliferation in and infiltration of the organ by enormous numbers of an immature type of white blood cell, causing enlargement of the organ and interference with its function to a greater or less extent.

The tumors are white to grayish pink in color, and of a fleshlike consistency. In some cases there is a uniform, diffuse infiltration of the organ by the tumor cells giving it a grayish-red appearance, while in other cases the tumor cells localize in the organ in the form of gray or white nodules interspersed with normal tissue. In this form of the disease, the internal

organs may become enormously enlarged by the white-cell infiltration; the liver sometimes weighs one pound or more, giving rise to the term "big liver disease."

"The blood form of the disease is usually accompanied by anemia, as indicated by pallor of the head and general unthriftiness. The blood is frequently thin and watery in appearance. On post-mortem examination there is usually enlargement of the liver and spleen, and these organs are brighter red than normal. Pin-point gray spots may be seen occasionally in the livers of young chickens. The kidneys may be either paler than normal or swollen and reddish. Small hemorrhages may sometimes be noted on the heart and intestines. There is also an extensive loss of flesh in many cases. Microscopic examination of the blood shows a great increase in the number of white blood cells."

"The bone form of the disease occurs but rarely. It consists in a thickening of the long bones especially the shanks which are most frequently affected."

The nature of the disease. The first symptoms of this group of diseases usually appear when the birds are from three to six months of age. Occasionally birds under twelve weeks, and more than a year old, are affected. Observations by research workers indicate that young chicks are most susceptible. Resistance increases with age until maturity at which time the bird is very resistant to natural sources of infection.

The period between exposure and the first symptoms varies with the form and virulence of the disease and the resistance of the bird. In the blood form it may be as short as one to two weeks, while with the nerve or paralysis type it appears to be approximately six weeks. The time between the appearance of symptoms and death also varies considerably. In some cases death may occur in a few days; in others the disease may become chronic and linger on for weeks or months. Disease changes in the eye do not become noticeable until the birds are about 4 months of age. Affected birds rarely recover.

Once the disease appears in the flock, it spreads slowly. A few birds are affected at one time but new cases develop continually; consequently, the losses over a period of a year may be high.

The disease is spread principally by contact with infected birds, buildings, parasites, wild birds and vermin. The attendant may also act as a carrier of the disease. Although it has not been indisputably established that the disease agent is passed through the egg to the chick, there is some evidence to support this view.

There are no particular breed or sex differences in susceptibility. There are differences, however, in susceptibility of different strains, families or individuals. Research workers have demonstrated that susceptibility or resistance to this group of diseases is inherited.

No drugs, tonics, medicines, vaccines, bacterins, or special feeds of any kind have been found effective in preventing or curing the disease.

Satisfactory recommendations for the control of avian leukosis complex are handicapped by lack of information as to the cause, dissemination, and live bird diagnosis of the disease. However, breeding for resistance to this disease and complete segregation of the young stock from the older birds offer the best means of control in the light of present knowledge. Complete segregation consists of rearing the pullets to at least 5 months of age on another farm or a distant range where paralysis or other diseases do not exist and where there are no older birds. A month before the pullets are brought back to the home farm all the old birds are disposed of. (See Chapter IX, page 177, for further preventive measures in rearing.)

In breeding for resistance to this disease, it is necessary to progeny-test all birds in the special matings to find the resistant families. Elimination of all birds with eyes having irregular pupils will help to reduce that form of the disease in

ordinary breeding flocks. Also, the incidence of the disease in pullets is usually less if they are hatched from hen eggs.

FOWL POX (CHICKEN POX)

Fowl pox is a highly infectious disease affecting the skin of chickens and turkeys. Pigeons and other fowl are affected with pox but not the same type of virus. The disease is transmitted by direct contact with affected birds, infected quarters, shipping crates, and other inanimate objects. Fowl pox may also be spread by mosquitoes. The rapidity of its spread and virulence in a flock varies considerably with different flocks. In acute cases the disease may spread through the flock in two or three weeks, while in the chronic form it may take several months. Fowl pox is much more common and serious with chickens than turkeys.

Fig. 173. Cockerel affected by fowl pox. Note the sores on the comb and wattles.

Small blister-like growths of a yellowish color appear on the comb, wattles or skin of the head. Later these sores become crusty and dry and are covered with dark brown scabs. There is inactivity, sneezing and coughing. The eyes are watery and, as the disease progresses, the eyelids may become stuck together or very much enlarged. The sinuses become infected, causing the face to swell. Diarrhea is frequently present. Usually there is a nasal discharge. The bird has no inclination, or cannot see, to eat. Death is frequently caused by a stoppage of the windpipe due to the inflammation and mucus which collects there. The disease may appear in three

forms. Cankers may be present on the inside linings of the mouth without any pox sores on the head, or the sores may come on the head without the cankers on the inside, or both may be present.

As soon as an outbreak of the disease is noticed all affected birds should be isolated and the remaining birds vaccinated. There are two types of vaccines to be used depending on the age of the birds and egg production: fowl pox vaccine for immature birds and birds out of production; pigeon pox vaccine for birds that are laying heavily.

Fowl-pox vaccine produces an immunity for life, but, used on

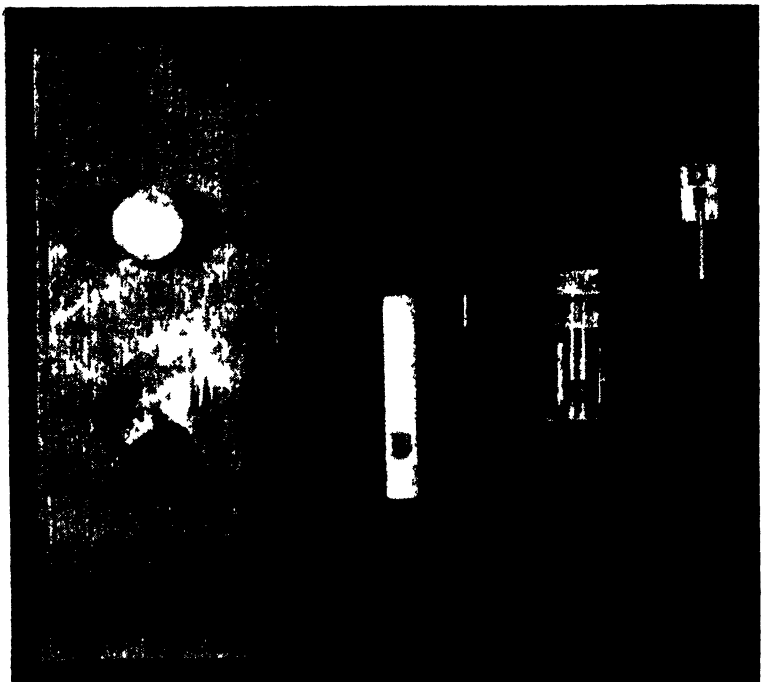


Fig. 174. Tools used in vaccinating chickens. A, Block of wood to hold the sticker, and B, the sticker, C, the vial containing the vaccine (500 doses), D, brush used to apply pigeon pox vaccine or fowl pox vaccine Note the sewing machine needles used in the sticker

laying birds, is quite likely to throw them out of production and cause some deaths. Pigeon-pox vaccine causes a mild reaction which does not affect egg production, but produces only a temporary immunity (about six months).

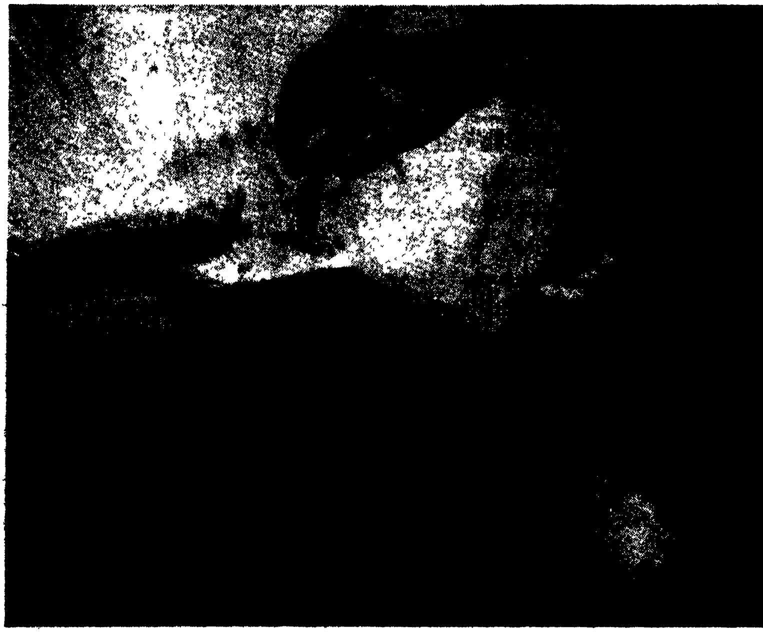


Fig. 175. Vaccination by the stick method. The vaccine is applied in the web of the wing where a few feathers have been removed to provide a clear surface. The needles are dipped in the vaccine and then jabbed through the wing. This method is more rapid than the brush method, but should not be used when pigeon pox vaccine is used.

Fowl pox vaccine consists of powdered fowl pox scabs mixed with distilled water. The scabs are secured from cockerels that have been inoculated on the comb with fowl pox virus. The scabs which are formed over the inoculated area are removed, dried and ground. The scab material is added to the liquid just before vaccinating, for once mixed it loses its potency rapidly if not kept in a cool place. Direct exposure to the sun is particularly harmful. The dry powdered scabs will keep for months without deterioration if kept in a cool place.

Fowl pox vaccine is applied either by the "stick" or brush method.

With the stick method two sewing machine needles are fastened ¼ of an inch apart in a small wooden handle about 3 inches long. The vaccination is made by dipping the needles in the vaccine and then puncturing the web of the wing. This breaks the skin and introduces the vaccine. Care should be taken to find a place free of feathers. Also, the large blood vessel should be avoided.

Fig. 176. Removing feathers from a bird's legs in preparation for fowl pox vaccination by the brush method. From three to five feathers are removed, if fowl pox vaccine is used. About 15 feathers, if pigeon pox is applied.

Slight swelling with scabs or "takes" develop on the skin at the points of vaccination; in other words, the bird has a mild attack of the disease. The "takes" are seen in from 5 to 10 days after vaccination and remain for about four weeks. Ten days following vaccination a check lot of birds should be examined for "takes." If no swelling or scab formation is observed it indicates the vaccine was not potent, the birds were immune, or the vaccine was incorrectly applied. If the vaccine or method is responsible, revaccination is necessary. It is always advisable to secure the vaccine from licensed laboratories.

The brush or "follicle" method of vaccination consists in removing three to five feathers from the front part of the leg between the hock and knee joint. The vaccine is painted over

the feather follicles with a small camels-hair brush. This method is much slower than the stick method.

Preventive vaccination is advisable in regions where the disease commonly occurs. This may be accomplished by vaccinating all the young birds each year with fowl pox vaccine

Fig. 177. Applying the vaccine with a camels-hair brush.

following an outbreak which has made the old birds immune. If there has been no previous outbreak in the flock both young and old stock must be vaccinated the first year.

The best time to vaccinate young birds is when they are from 3½ to 4 months of age. Unless all the young birds are vaccinated at the same time strict segregation of the vaccinated birds should be maintained until all the birds have been

handled. Only strong healthy birds should be vaccinated. Heavy mortality may result where birds are weakened by disease or infestations of parasites. Old birds vaccinated with fowl pox vaccine should be out of production; otherwise the mortality may be high.

Fig. 178. Scabs appearing on leg of bird 10 days after vaccination for fowl pox.

FOWL TYPHOID

Fowl typhoid is caused by a microscopic rod-shaped organism known as *Salmonella gallinarum*. The disease attacks chickens, turkeys, pigeons, and other domestic species. The bacillus gains entrance into the blood-stream through the digestive tract. Healthy birds contract the disease by eating feed and drinking water contaminated by the droppings of affected fowls.

Chickens affected with fowl typhoid show loss of appetite, increased thirst, due to fever, dullness, weakness, ruffled feathers, and drooping wings. They sit quietly with the eyes closed and the head drawn close to the body. The comb, wattles, and face usually show an anemic condition although they may be bluish in color. The droppings have a greenish or yellowish color and often an offensive odor.

The internal parts of the body seem paler than normal. The blood is pale red in color and thin and does not clot readily. Inflammation is often found in the inner lining of the small intestine. The liver is very large and of a brownish-bronze or mahogany color covered with grayish spots. It has a tendency to break easily. The spleen is usually swollen, pulpy, and

filled with grayish spots. The kidneys are enlarged, lighter in color, or slightly reddened with blood.

A careful laboratory examination is necessary to distinguish fowl typhoid from fowl cholera. Many of the symptoms of typhoid are common also to cholera, the principal difference being that cholera runs a more rapid course than typhoid. Symptoms of the disease may last from three to fourteen days. Fowl typhoid is best controlled by keeping the houses and ranges in a reasonably sanitary condition and raising the young stock away from the hens. The old birds are then disposed of before the pullets are housed. As a preventive measure in case of an outbreak in the community the flock may be vaccinated with a fowl-typhoid bacterin made from Salmonella gallinarum. The inoculation is usually made under the skin covering the breast muscles on the bare spot under the wing.

Fowl typhoid carriers may be detected and removed by the test used to detect pullorum carriers. This is possible because the organisms of the two diseases are closely related. So far as is known this test has not been used as a means of eliminating the disease.

GOUT

Gout is a diseased condition of the kidneys. Its cause is not known. The normal functions are thought to be affected either by over-exertion or toxic material passing through them. Vitamin deficiency may also be responsible.

Gout is usually chronic. It is most common in older birds, but chicks two weeks old have been known to be affected. Two types of gout have been observed; visceral and articular. With visceral gout, white, chalklike deposits of urates are found over the heart, the liver, the lining of the body cavity, and throughout the kidneys. In articular gout the joints swell and there may be a discharge from tumorlike growths at these points. The kidneys are usually swollen.

Affected birds droop, become weak and emaciated; and lameness may appear. Birds may die suddenly or remain inactive for some time. Losses vary.

Treatment consists in eliminating possible causes of the condition. Plenty of water and the liberal feeding of green food may help.

INFECTIOUS CORYZA (COLDS, ROUP)

Infectious coryza is an acute infectious disease affecting the nasal passages and sinuses, and occasionally the larynx and trachea, of chickens. It is caused by a bacterial organism known as Hemophilus Gallinarum. Infectious coryza is highly contagious.

The first symptom of infectious coryza is a sticky, thick, yellowish white discharge from the nasal openings which causes some difficulty in breathing. The eyes become watery and there is a characteristic odor. If the disease continues unchecked, the discharge may fill the sinuses causing a swelling of the face with cheesy masses under the eyes which partly, or entirely, close the eyes. The wattles may become swollen and enlarged. The odor becomes very offensive. This latter stage of the disease is called roup. A roupy condition affects the appetite as well as the bird's ability to see to hunt for its food. Death results from a progressively weakened condition brought on by lack of food and difficulty in breathing due to the plugged condition of the air passages. Economically the loss in egg production makes this disease one of the most important to the poultry industry.

The duration of infectious coryza may be short, with recovery within two weeks, or it may persist for one or more months depending on the virulence of the organism. Some of the birds that recover may become carriers.

Infectious coryza may be distinguished from the other respiratory diseases by the isolation of the causative organism. This can only be done in a well equipped laboratory.

No vaccines have been effective in the control of this disease; consequently, its control is through eradication. This may be accomplished, first, by rearing the young stock free of the disease by placing them on another farm or range some distance away where contact with the older birds is impossible; second, by disposing of all old birds and cleaning the house before the pullets are housed. Pullets should never be housed with old hens because of the danger of infection from "carrier" birds.

INFECTIOUS LARYNGOTRACHEITIS

Infectious laryngotracheitis is a highly infectious respiratory disease of chickens. It is caused by a filterable virus. The disease is well distributed throughout the United States. Death rates range from 5 to 80 per cent of the flock. Birds may be affected at any age. Usually it is more acute among pullets and old birds. Birds that survive are immune but some may become chronic carriers of the disease. In this way they perpetuate it on the home farm and may introduce it to other flocks.

When infectious laryngotracheitis appears among chicks the spread is rapid, growth is retarded, but they do not die suddenly. The death rate may be large in time as weak birds are constantly removed. The attack usually appears when the chicks are from one to six weeks of age.

Affected chicks are inactive, stop eating, act feverish, and congregate in the warmer part of the hover. There is a watery discharge from the eyes which moistens the adjacent down. The eyelids may become swollen and a few chicks may gasp. Infectious laryngotracheitis and infectious bronchitis of chicks have much the same symptoms. In many cases it is necessary to make a laboratory test to distinguish between them.

Among the older birds an outbreak of the disease quickly spreads through the flock with varying degrees of severity and death rate.

The first indications are a gasping for breath. The bird sits with neck drawn in, the head drooping and the eyes closed. The head is suddenly thrown upward and outward with the beak opened at each inhalation of air. This is accompanied by a loud wheezing noise. There is frequent coughing or spasmodic exhalation which often results in masses of clotted blood being expelled from the trachea. The eyelids are often glued together by collections of mucus or caseous exudate in the eyes. A discharge appears at the nostrils which may extend to the sinuses and bring on a condition similar to roup.

Post-mortem examination shows the linings of the trachea and bronchi to be greatly inflamed and the passages wholly or partly filled with mucus and clotted blood. The proportion of mucus to clotted blood and the amount and extent of the inflammation varies. The color of the mucous membranes varies from a normal appearance to a bright scarlet, according to the amount of inflammation. The lungs look normal except for small areas of congestion. Death appears to be due often to strangulation caused by the larynx or trachea being filled with thick mucus and clotted blood.

Very little, if anything at all, can be accomplished by medical treatments either for the chicks or older birds. Dusts or sprays may give some temporary relief but are worthless as a permanent cure.

The most seriously affected of the older birds may be removed to separate quarters for individual treatment. Heat has been found to be beneficial in cold weather.

The control of infectious laryngotracheitis in baby chicks is difficult; consequently, if the flock is not too large, and the attack is severe, it is best to dispose of them. If this plan is followed all brooder houses and equipment should be thoroughly cleaned and disinfected before other chickens are placed in them. If the chicks are more than five weeks old, the disease may be checked by vaccinating the unaffected birds.

The control of the disease in older birds may be accom-

plished in three ways. First, the spread of the disease may be checked in the early stages of an outbreak by vaccinating the unaffected birds. This will require the vaccination of all young stock in the future.

The second plan is to dispose of all birds and restock after the premises have been thoroughly cleaned and disinfected.

The third procedure consists of growing the young stock on a separate farm with a separate caretaker. Before the pullets are brought back to the home farm, all the old birds are disposed of and the buildings properly cleaned and disinfected.

Dr. Burnett [6] describes the vaccination technique as follows: "The vaccine is applied to the mucous membrane on the upper part of the cloaca. The bird is held by an assistant, and the upper part of the vent is rolled open with the thumb and forefinger. A stiff brush is moistened with the vaccine. The exposed mucous membrane is brushed back and forth several times. In young birds only moderate pressure should be placed on the brush. Older birds require more pressure. A slight bleeding of the mucous membrane may result, but this does no harm."

"Some prefer to place the vaccine in the bursa of Fabricii with a syringe. Some practice is necessary before one can become proficient with either method. Five days after vaccination, a swelling of the upper part of the vent should be evident. This indicates a 'take.' Birds not showing this 'take' should be revaccinated."

Young chickens are best vaccinated for preventive purposes when they are about six weeks old. Birds may be vaccinated for both infectious laryngotracheitis and fowl pox at the same time (between six and fifteen weeks of age).

Certain precautions are helpful in preventing the introduction of infectious laryngotracheitis and other respiratory diseases into a flock free of these diseases. They are as follows:

1. Make flock replacements only in the form of hatching eggs or chicks.

[6] Cornell Extension Bulletin No. 332, 1939, p. 49.

2. Avoid the introduction of any adult birds, except from sources known to be free of respiratory diseases.
3. Quarantine birds returning from poultry shows, egg-laying tests, etc., for one month, or dispose of them.
4. Shipping crates other than those used on the premises should be thoroughly disinfected before they are used.
5. Cullers, pullorum testers, or other handlers of birds, should wash their hands, change their clothes, and clean their footwear before coming on the premises.

OMPHALITIS (MUSHY CHICK DISEASE)

Omphalitis or navel infection is an uncommon disease that occurs among newly hatched chicks and poults. It is caused by bacterial infection of the unhealed navel and yolk sac at hatching time. The navel itself not only becomes infected but the bacteria are carried into the body cavity. It is the result of unsanitary conditions which increases the number of bacteria in the incubator.

Affected chicks are drowsy. The abdomen appears mushy and puffed and there may be diarrhea. The navel opening does not heal properly and frequently a definite scab forms over the opening. A post-mortem examination shows evidence of infection around the navel. The kidneys and liver are pale and swollen, and the contents of the yolk-sac are more fluid than usual and have a putrid odor. Most losses occur within seventy-two hours after hatching.

There is no satisfactory treatment for affected chicks. Navel infection can be controlled by strict sanitation in the incubators and hatchery. The incubators should be thoroughly cleaned and fumigated between hatches.

If an outbreak occurs, fumigate the incubators between the hatches with 2½ times the usual amount of chemicals used at hatching time. It is usually advisable to clean, disinfect and fumigate the hatchery to completely eliminate all trouble. Details of fumigation are given on page 119.

PULLET DISEASE (BLUE COMB)

This disease usually affects recently housed pullets, but may appar among younger birds on range, or hens during the summer and early fall months. Outbreaks have occurred principally in the northeastern part of the United States.

The presence of the disease is indicated by a sudden drop in egg production and food consumption, a bluish discoloration of the comb, droopiness and diarrhea. Severely affected birds die within a few hours, while milder cases recover. The condition usually spreads through the flock rapidly. Mortality may be rather high.

Post-mortem examination shows great variation in symptoms. In many instances there are disturbances in the liver, pancreas, and kidneys, and more or less inflammation of the intestines. Attempts to isolate a specific causative agent have been unsuccessful. Some pathologists suggest the possibility that uremic poisoning or indigestion may be a cause. Others feel that more than one disease is responsible.

Jungherr [7] suggests the following treatment when symptoms of the disease appear. Remove the regular mash and grain and give the flock a special wet mash for three hours daily for one week, the composition of the wet mash being 50 parts ground oats, 50 parts wheat bran, 10 parts molasses and 5 parts water. The birds should be allowed all the water they wish to drink.

PULLORUM DISEASE

Pullorum disease is a highly contagious and fatal disease of young chickens caused by infection with a microscopic organism known as *Salmonella pullorum*. Infections also occur in adults but, being localized in the ovaries, the birds seldom show any symptoms of it.

[7] Jungherr and Levine, Am. Jour. of Vet. Research, Vol. II, No. 4, July, 1941, pp. 261–271.

The infection reduces egg production and causes some mortality. Some of the eggs from diseased hens carry the infection and transmit it directly to chicks hatched from them. As a matter of fact, this is the most common and principal source of infection. Contaminated incubators and brooders and diseased chicks are also spreaders of the infection.

Signs of the disease usually appear within two or three days after the chicks are hatched and continue until they are three or four weeks old. The greatest losses come during the first two weeks. Losses are usually less if the infected chicks are brooded carefully. Chilling and shipping seem to increase the severity of the infection and the losses.

Affected chicks are drowsy and remain under the hover in groups. They stand with drooping wings and walk with an unsteady gait. They do not eat. The droppings may be white and sticky, or brownish in color and cling to the down and vent to such an extent as to block the vent, in which case the chick

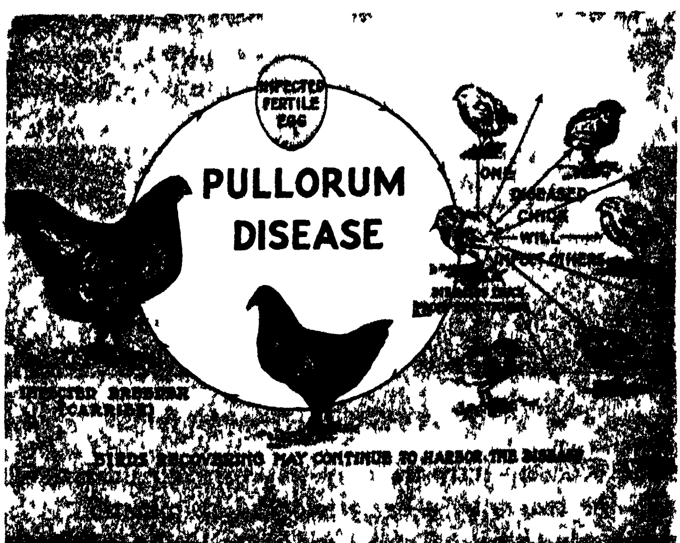


Fig. 179. Cycle of infection with pullorum disease.

soon dies. In any case the chicks grow weaker and in a few hours or days death follows. Mildly affected chicks that survive appear weak, unthrifty, and dull, with a tendency to the development of a large abdomen. Such chickens when they reach maturity appear healthy, but may be carriers and spreaders of the disease.

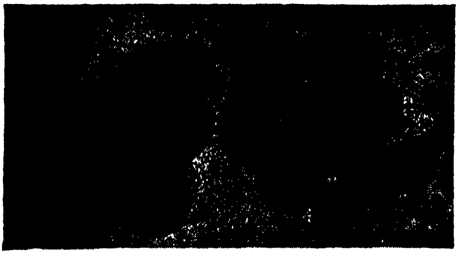


Fig. 180. Left, normal ovary, showing blood vessels and plumpness of ova. Right, ovary infected with pullorum disease. Note irregular ova and lack of blood vessels. (Conn. University.)

A post-mortem examination of dead chicks may show firm whitish abscesses in the lungs caused by inhaling down or dust in the incubator which carries the germs. Similar abscesses may be found in the wall of the gizzard, in the liver, and in the heart muscles. A white stringy material may cover the heart.

The symptoms of "common" diarrhea and those infected with *Salmonella pullorum* (pullorum disease) are practically

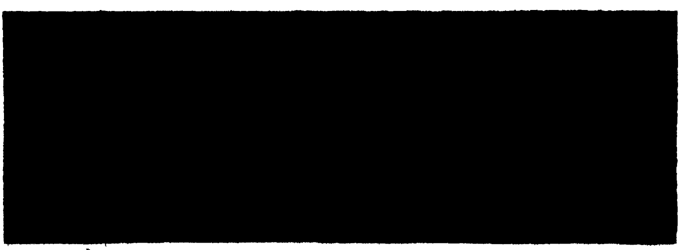


Fig. 181. Chicks affected with bacillary white diarrhea.

the same. Consequently the only way to distinguish definitely between the two is by a bacteriological examination.

Among adult birds, females are more likely to be affected than males. Heavy breeds such as Rhode Island Reds, New

Hampshires, Plymouth Rocks, etc., are more frequently and seriously affected by this disease than light breeds like the Leghorn. The death rate among mature birds is usually not high. Birds with badly infected ovaries practically cease laying but, aside from occasional signs of weakness and emaciation, appear normal.

Post-mortem examination of infected hens shows the yolk ovules to be irregular in size and shape, and varying in color from yellow to dark brown. The hearts may be enlarged and covered with a whitish cheesy material.

No successful treatment for pullorum disease has been found.

As in the case of tuberculosis, two methods of procedure are open to the poultry-keeper when pullorum disease is found in the flock. The first plan is to dispose of the flock, if it is not too large and does not involve too great a financial loss, and begin all over again with disease-free stock. In the meantime, of course, the premises should be cleaned and disinfected thoroughly.

The latter plan is to have the adult flock tested for pullorum disease by means of a blood test known as the agglutination test. "This test is used to detect many diseases among animals and man. The blood test for Bang's disease in cattle is one and the Widal test for typhoid fever is another. In order to perform this test, some blood of the infected animal and a suspension of the germs which cause the disease are needed. The blood of infected animals causes these germs to form clumps, and the blood from normal animals does not. The diagnosis is based upon whether this characteristic clumping is obtained."[8]

THE AGGLUTINATION TEST FOR PULLORUM DISEASE

There are three methods of performing the agglutination test for the detection of *Salmonella pullorum* in mature fowls.

[8] Dr. E. L. Brunett, Cornell Extension Bul. No. 337, p. 23.

The first is commonly called the "standard tube" method; the second is known as the "rapid serum" test; and the third is referred to as the "rapid whole-blood" test. A fourth method, known as the "wattle test" has been tried but found unsatisfactory. Although the standard tube method has been considered the most accurate among veterinarians, improvements in antigen and the technique of conducting the rapid whole-blood test in recent years have made it equally effective. All three tests have been accepted as approved methods of testing chickens for pullorum disease by the United States Department of Agriculture in administrating the pullorum control and eradication phase of the National Poultry Improvement Plan.

None of these tests is infallible because of inaccuracy in testing technique or variations in the physical make-up of the bird which affect the diagnosis. But throughout the United States complete freedom from pullorum disease has resulted where approved methods of testing have been used on entire flocks of poultry, followed by prompt removal of the reactors and the use of proper sanitary measures.

Beach and Michael[9] describe the "standard tube" test as follows: "A sample of blood is drawn from each bird (usually from a small vein near the middle joint of the wing) in small vials or test tubes." The vials of freshly drawn blood should be placed immediately in such a position that the blood will clot along one side of the tube. "After the blood is clotted, the vials are put in a cool place until the serum or clear liquid portion of the blood has separated from the clot. A minute quantity (usually from 0.01 to 0.04 cubic centimeters) of serum of each sample is mixed with a small amount (usually 1 c.c.) of test fluid or antigen in a test tube. The antigen consists of cultures of bacterium pullorum in suspension in 0.85 per cent of sterile salt solution containing a small amount of phenol or other preservative and is slightly cloudy. The serum antigen mixture is allowed to stand for twenty-four hours or

[9] Univ. Calif., Bull. 486, Jan., 1930.

longer at incubator-room temperature before a reading of the results of the test is made. If the blood serum contains what is known as agglutinins the organisms in suspension in the antigen are caused to clump together and sink to the bottom of the tube with consequent clearing of the fluid. This is known as a positive reaction. If the blood serum contains no agglutinins, the antigen remains turbid. This is known as a negative reaction."

The second method of testing already referred to is known as the rapid serum test. Results from this test compare favorably with the method just described and the work can be done more rapidly. The test is made by mixing small amounts of blood serum and concentrated antigen on a pane of glass. The reaction is completed in one to fifteen minutes.

The reading of the reaction to both the standard tube and the rapid serum tests is made in the laboratory.

The rapid whole-blood method of testing was first suggested by workers in the United States Department of Agriculture, Bureau of Animal Industry. This test is done at the farm. Since the diagnosis is made in a few minutes, the birds are held until it is known whether they are reactors or not. This test is popular among poultrymen because it eliminates rehandling the birds and is fast.

The test is made by mixing a drop of fresh blood from the wing vein of the bird with a drop of antigen on a pane of glass. The glass is ruled in 1-inch squares and forms the top of a small box in which heat is supplied by electricity or hot water. An electric lamp is desirable as it illuminates the glass and provides heat as well. The temperature of the glass should be kept between 60 and 80° F. for best results. Each test occupies one of the squares. The reaction is usually visible in 5 seconds to 2 minutes. Slight reactions which require more than 2 minutes should be disregarded. A positive reaction results in a clumping of the antigen in clusters surrounded by clear spaces.

When the control of pullorum disease is based on blood testing, the following eradication and preventive measures have been found effective: (1) if infection is present all birds in the flock more than 4 months of age should be retested within four to six weeks until no reactors are found; (2) all reactors should be promptly removed from the premises; (3) all breeders should be tested annually once the flock is free of reactors; (4) avoid custom hatching; (5) eggs, chicks or stock should be purchased only from pullorum-free flocks; (6) removal of diseased fowls should be accompanied by careful renovation and disinfection of the incubators, brooders and houses; (7) birds returning from poultry shows or egg laying tests should be quarantined and blood-tested before they are added to the flock; (8) the feeding of raw eggs should be avoided.

AVIAN TUBERCULOSIS

Tuberculosis is a chronic infectious disease which affects practically all species of domestic birds and many species of wild birds in captivity.

There are three recognized varieties of tubercle germs: human, which causes tuberculosis in man; bovine, which causes tuberculosis in cattle, swine and man; avian which causes tuberculosis in poultry, swine, cattle, and in rare cases, in man.

Infected birds only show external signs of the disease in the most advanced stages. Such birds become emaciated, the comb and wattles are pale and shriveled, some are lame, and toward the last there is dullness with a yellowish or greenish diarrhea.

Post-mortem examination usually shows the glandular organs and intestines to be covered with tubercles. The lungs of chickens are not as frequently attacked as is the case in humans and mammals. The lesions consist of round light yellow spots, sometimes of a solid cheesy consistency, varying in size from a pinhead to a small walnut.

Tuberculosis usually affects birds about one year old or older.

There is no cure for the disease.

Tuberculosis can be controlled in two ways, once it is found in the flock. The method used depends on the size of the flock and the extent of the disease.

The first method consists of disposing of all the birds on

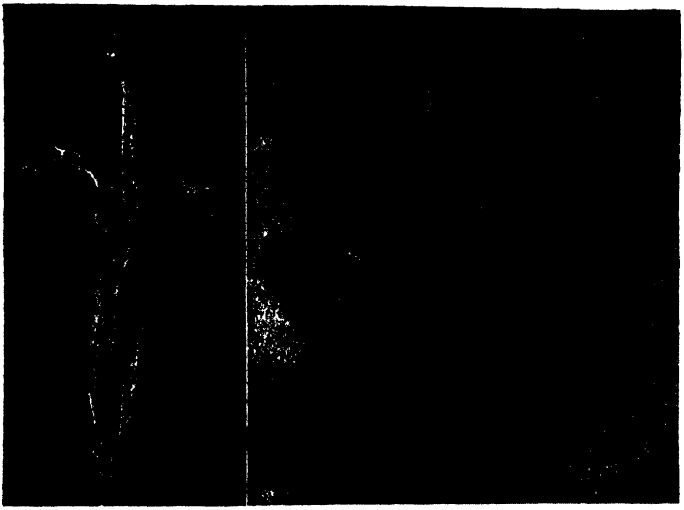


Fig. 182. Advanced case of tuberculosis. Left, carcass showing extreme emaciation. Right, tubercles on the liver and intestines. (Montana Exp. Station.)

the place and then starting over again with new clean stock, the houses, equipment and yards having been thoroughly cleaned and disinfected in the meantime. This plan is particularly applicable for small flocks.

The other method of combating the disease is by means of the tuberculin test. This test is made by injecting 1/15 to 1/20 c.c. of a special fluid known as tuberculin just beneath the outer skin of the wattle by means of a very fine hypodermic needle. If the bird has tuberculosis the wattle will swell. The swelling usually appears within 24 hours after the injection, but in the majority of cases it does not reach its greatest swelling until 48 hours, when the examination is usually made.

Since most of the infection is likely to be in the old stock, all birds more than two years old should be sold. The yearlings and birds more than four months of age should be tuberculin-tested every six-months, and reactors should be promptly removed. The young stock should be reared away from the old ranges and yards. The pullets and cockerels should be housed separately from the yearlings. Constant elimination of infected birds, segregation of young and old, and sanitation are necessary to control this disease.

Tuberculosis is an important disease in the middle west where a large percentage of small flocks in some localities are infected. Swine are particularly susceptible to the avian type of the tubercle bacillus. According to government reports nine-tenths of the tuberculosis lesions in swine are caused by the avian organism.[10]

The tuberculin test is particularly recommended: first, when introducing new breeding stock into the flock; second, to find out whether the flock is affected with tuberculosis; third, to detect whether certain very valuable birds have the disease when it is known to be present in the flock in order to save them from infection.

Healthy fowls contract tuberculosis by eating food and liquids contaminated by the discharge of diseased birds. Tuberculosis is most commonly introduced when diseased stock is purchased. Rats, sparrows, pigeons and mice may carry the disease from yard to yard and even from farm to farm.

The germs of tuberculosis are not easily destroyed and may remain alive and virulent in a moist and dark protected place for as long as 2 years. Thorough sanitation, therefore, plays a very important part in the control of this disease.

VENT GLEET

This is a disease of fowls which is generally considered to be be infectious and transmitted by the male birds. Its causa-

[10] U. S. D. A. Year Book, 1942, p. 241.

tive agent is not known. It starts with a severe irritation of the vent accompanied by a watery discharge. Later the vent becomes sore and is covered with thick brown scabs, or yellowish-white cankers, which have a disagreeable odor. The condition may throw the birds out of production but seldom causes mortality. However, the birds are not salable.

Affected birds should be removed from the flock and either killed or treated. Treatment consists of washing the parts with warm soapy water and applying zinc oxide or mercurial ointment. The treatment is repeated frequently.

INTERNAL PARASITES

Worms are the most common internal parasites of poultry. They cause stunted growth, weakness, emaciation, lowered egg production in laying birds and death in chickens of all ages.

Chief sources of worm infestations are: (1) worm eggs; (2) contaminated litter and soil; (3) contaminated food and water; (4) contact with the droppings of infested birds; (5) consumption of intermediate hosts such as flies and beetles or other low forms of animal life, such as snails or slugs, which are necessary for the completion of the life circle of the parasite; (6) by animals, wild birds or the attendant carrying infection material on their feet from one house to another and by the careless use of contaminated equipment.

Large numbers of worms rob birds of considerable food, interfere with digestion and have a toxic or poisonous effect which lowers the resistance of the flock to such an extent that they are more susceptible to other diseases. Often the effect of an infestation of intestinal worms is so insidious that the cause is not suspected or entirely overlooked. If the flock does not appear normal, examine a few birds for worms.

Chickens may be infested with several different types of worms. The most common kinds in the order of their importance are: (1) tape worms; (2) round worms; (3) hair

worms; (4) gape worms; (5) eye worms; (6) cecal worms, (7) gizzard worms.

The external symptoms of round-worm and tape-worm infestation are very similar. The presence of a few round-worms is not serious and produces few, if any, outward changes. On the other hand, a few tape-worms cause considerable damage. With heavy infestations, the birds become thin, weak and unthrifty; the feathers are ruffled; the comb and wattles are pale; the beak and shanks of growing chickens of yellow-skinned breeds lose their color; and laying birds fall off in production. Disturbances in the digestive tract are indicated by loss of appetite and by diarrhea.

Fig. 183. Intestinal worms. Common round worms on the left; at the right, a tape-worm; center, caecum-worms.

Post-mortem examination shows the walls of the intestine, a few inches from the gizzard, to be pink or red from the irritation and inflammation on the inside. Usually the intestines are ribbed and nodules may be noticed. On opening the intestines the inside linings are swollen and puffy with large amounts of soft jelly-like material sloughing off.

Preventive measures. Worm infestations are largely the result of unsanitary conditions. (See Chapter IX for sanitary program.)

Tapeworms. The species of tapeworms in poultry vary in size from those too small to be easily seen without a microscope, to 5 inches in length. These worms are white and flat with a "head" or scolex by means of which they attach themselves to the walls of the intestine. The body of the worm is

made up of segments each one of which is complete in itself and possesses both male and female genital organs capable of self-fertilization. As new segments are formed near the head, the old segments when mature, or full of eggs, are released by the parent worm and pass out with the droppings. The eggs are then eaten by some other animal or insect such as earthworms, snails or flies, called an intermediate host. Here the young tapeworm develops to a certain point and then remains dormant until the host is eaten by poultry, when the larval tapeworm continues its development until mature. Poultry cannot become infested with tapeworms unless the eggs have passed through this period of growth in an intermediate host.

Tapeworm remedies. Remedies for the control of tapeworms have not been very successful. The tobacco dust treatment as recommended for roundworms is worthless for tapeworms.

The reason why tapeworm remedies are not very effective is that it is necessary to destroy the head of the worm and this is difficult since the head is usually buried deep in the tissue.

Prevention is the best remedy. Young chickens are much more susceptible to tapeworm infestations than adult birds. The old stock is usually the source of the parasite, consequently, the young stock should be kept entirely separate from the old birds during the period of growth.

The old wormy birds should be removed or quarantined. At the end of the season such a flock should be sold and the premises cleaned before the pullets are housed for the winter.

In the meantime, the poultry manure should not be used as fertilizer near the poultry plant or on the range where the young stock is being reared. During the warm months, the manure should be kept in covered screened pits or moved away frequently to a distant part of the farm. Every precaution should be taken to prevent the young chickens from eating insects that may have been feeding on the manure or litter from infected birds.

Roundworms. The roundworms found in the small intestine are yellowish-white in color and range in length from ½ to 3 inches. The mature female worms are constantly depositing hundreds of eggs, microscopic in size, which pass off in the droppings. After a few days' exposure in the air with the proper temperature and moisture conditions, a tiny young worm develops in the egg which, when it is taken in with the food, promptly hatches and soon becomes a mature worm in the bird's intestine. An intermediate host is not necessary for the spread of this parasite between birds.

Roundworm eggs are covered with a tough lining which makes them very resistant to extremes of heat and cold as well as ordinary disinfectants. The eggs will remain in the soil in a healthy condition for months and even years.

Experimental evidence at the California Agricultural Experiment Station and at Cornell University indicates that nicotine is one of the most effective and economical vermifuges for roundworms. The nicotine can be supplied by means of tobacco-stems or dust fed in the mash. However, owing to the variation in the strength of the nicotine obtained in this manner and the amount consumed, as well as the fact that many birds which need it the most often refuse to eat the mash, individual treatment with capsules containing a definite amount of nicotine is considered better. The capsule method requires no previous starving of the bird for several hours and is not, therefore, so likely to interfere with laying.

If tobacco dust is fed in the mash, it must contain from 1.5 to 2 per cent nicotine. Add 2 per cent by weight to the mash and feed the mixture for a period of 4 weeks. The treatment may be repeated at intervals of 3 weeks.

Tetrachlorethylene or carbon tetrachloride is also effective in removing roundworms. One cubic centimeter is given to each bird in a gelatin capsule.

Treatment with nicotine capsules should be followed by a dose of epsom salts, at the rate of 1 pound for each 100 adult

birds in as much water as will be consumed in three to four hours.

Forty-eight hours after capsuling, when the worms are practically eliminated, all parts of the house should be cleaned to prevent reinfestation from worm eggs already present. As previously explained, chemical sprays are of little use in destroying the eggs, therefore reliance should be placed on thorough cleaning of the house and plowing of the yards to clean up the premises. Inasmuch as moisture in the soil plays such an important part in the growth of the embryo in the worm eggs, filling up the muddy holes in the yards and preventing wet spots around outdoor drinking places will help to check the development of worm eggs and, therefore, tend to cut down reinfestation.

Hair worms. The hair worm is grouped with the so-called microscopic worms. It is approximately one-half inch in length and the same thickness as a hair.

The parasite is found in the intestine, but it invariably burrows into the intestinal wall. In a heavy infestation the intestinal wall is thickened, and when the intestine is opened, thick, slimy material is usually found. Because of the minute size of the parasite, it is very difficult to find it without the aid of a microscope. For this reason, the presence of this worm is often overlooked.

Present information indicates that the life cycle of the hairworm is similar to the large roundworms. In other words, growing chickens become infested with these worms after picking up the developed worm eggs with the feed and water.

The symptoms of hair worms is the same as roundworms. As treatment is not satisfactory the same preventative measures are suggested as for round worms.

Gapeworms. Gapes is a disease of young chickens, turkeys and pheasants caused by a Y-shaped small reddish worm (*Syngamus trachealis*), about ½ to ¾ inch in length, which attaches itself to the internal lining of the windpipe. It sucks

blood from the mucous membrane and obstructs the passage of air.

Eggs from these worms are either coughed out or swallowed and passed off in the droppings. They then go through a period of incubation in the soil after which they are capable of continuing their development when swallowed by the chicken. Gapeworm eggs may live for months in the soil and are often eaten by earthworms. In badly infected ground, the earthworm is a common source of infection for chicks.

Death from gapes is frequent and is due to a lack of the normal supply of air, the loss of blood, and weakness from the exertion in attempts to expel the worms.

The affected chick gapes with the neck and head thrown upward and forward with each intake of air. The bird sneezes frequently in an attempt to dislodge the obstruction. It often stands or sits for hours with the eyes shut, gaping regularly. Loss of appetite is followed by rapid emaciation. Symptoms of gapes usually appear when the chicks are from ten days to four weeks old.

Temporary relief may be provided by passing a looped horsehair or quill feather down the windpipe and removing some of the worms. Three drops of creolin in each pint of drinking water is also suggested. Prevention is the best method of combating the disease.

The chickens should be brooded on new clean ground in clean buildings. The old runs should be plowed, and no attempt made to brood little chickens on them for three or four years. Turkeys are thought to harbor gapeworms, consequently chickens and turkeys should not be reared together.

Cecal worms. The cecal worms are small parasites about ½ to ¾ inch in length found in the ceca (blind guts) of the intestine. They are similar in appearance to the roundworms in the small intestine. Because of their sheltered position they are difficult to treat.

Treatment consists of feeding phenothiazine. The dose for

an adult chicken is 0.5 gram. Phenothiazine may be fed in the mash or given individually to hens in the form of pills or capsules. Since the damage due to this worm apparently is slight, treatment is hardly necessary.

Infection occurs in the same manner as described for roundworms and the same preventative measures apply.

Gizzard worms. Gizzard worms are small red worms coiled in the flesh under the outer skin of the muscle of the gizzard. On account of their isolated position, they are difficult to treat. An intermediate host, the grasshopper, transmits this worm. Individual birds may be seriously affected, but flock trouble is not often seen. Treatment of infested birds is not successful. Control consists of rearing birds away from insects and of disposing of old infested bird.

Eye worms. This parasite is found principally in the southern part of the United States. The worm is found in the transparent membrane which passes over the eyeball of the bird in winking. The worms are hair-like and transparent and are about three-fourths of an inch in length. They can be seen on the eyeball after pressing firmly on the tear sac at the corner of the eye to drive them out. The cockroach has been found to be the intermediate host of this worm. Chickens, turkeys, peafowls and wild birds may become affected.

The eyes of affected birds are irritated and they rub them frequently on the feathers of the wing or scratch them with the feet. Often there is severe inflammation around the eye, with puffiness and a discharge from the nostril which resembles a cold. The eyesight is poor and blindness may result.

The Florida Agricultural Experiment Station recommends the following treatment as most effective: "Drop into the eye of the fowl a 5 per cent solution of butyn as an anæsthetic; then, lifting the nictitating membrane of the eye, place 1 or 2 drops of a 5 per cent solution of creolin directly on the worms. Immediately after applying the creolin, wash it out well with water; the worms will have been promptly killed by it."

Prevention of eye worms consists in removing all material that will harbor cockroaches.

Other worms. Other kinds of worms are found in the walls of the crop and in the glands of the stomach, proventricular worms, but these parasites are not particularly harmful. In most cases there is no practical method of treatment. Control consists in rearing the birds away from insects and disposing of all old infested birds.

Flukes are small flattened unsegmented worms. They are found in the intestinal tract, lung, liver or some other internal organs and under the skin of the body. At least 3 species of flukes have been reported in the United States principally in the north central section. Certain species of snail and the dragon-fly act as intermediate hosts. Flukes have been found in English sparrows and crows. Swampy land should be avoided and sparrows excluded from buildings. Flukes are not common parasites of poultry at the present time.

EXTERNAL PARASITES

Lice (Figs. 184, 185). All domestic fowls are more or less infested with lice. Their life history is simple for they begin and end their life on the body of the bird. Lice live on bits of feathers and on the scales of the skin. Their constant activity and sharp claws irritate the skin of a bird, weaken its vitality, thereby giving various diseases a chance to develop.

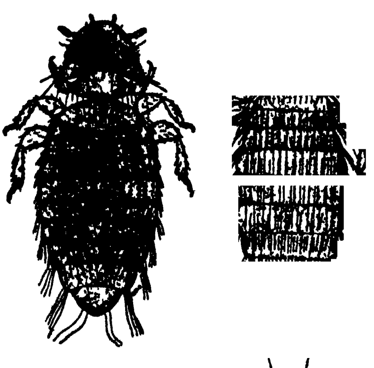


Fig. 184. Common large hen louse. (Cornell University.)

Lice vary in size but are seldom over 3/16 inch in length. They are yellow or grayish in color. They lay their eggs in clusters near the base of the feathers, usually

just below the vent. The eggs hatch in five to seven days and the young lice become full grown in two weeks.

The most convenient as well as efficient method of treating hens for lice is by the use of 40 per cent nicotine sulfate. A small amount of this material is applied to the roosting poles by means of a brush or machine oil-can, about an hour before the birds go to roost. One ounce of nicotine sulfate is required for about 10 feet of roosting space.

The fumes from the drug pass upward through the feathers and suffocate the lice. A second application must be made 10 days later to destroy the young lice that hatch after the first application. Plenty of fresh air should be provided during the treatment.

Blue ointment or mercurial ointment diluted with from 1 to 2 parts of vaseline can be used as an individual treatment for adult birds. It is very effective. A small portion of the ointment, about the size of a small kernel of corn, should be applied with the tip of the finger to the skin just below the vent, being careful not to get any of it in the vent. One application will last for some time as the nits which hatch out later, as well as the adult lice, are killed. Blue ointment is a deadly poison and should be handled with discretion.

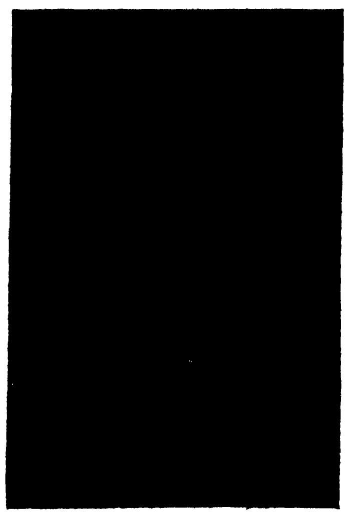


Fig. 185. Eggs of the common hen louse. (Cornell University.)

Sodium fluoride, a white powder, is also used in the eradication of lice. While the bird is held by the feet with the head down, pinches of powder are placed between the feathers next to the skin of the head, neck, breast, back, wings, and below the vent. Care should be

taken not to get the powder in the bird's eyes as it is very irritating. Sodium fluoride may be applied in the form of an ointment by mixing 1 ounce of it with 2 ounces of petrolatum or vaseline. Since sodium fluoride is poisonous to humans and animals when taken internally, care must be exercised in its use. It is also very irritating to the eyes and nose of the operator. It should not be used on hens brooding chicks.

For head lice in chicks carbolated vaseline or lard is recommended. This is rubbed into the down on the neck and below the vent.

Poultry mites (Fig. 186). Of the eighteen or more different species of mites, the common red mite is probably the most destructive to poultry. The adult is just visible to the naked eye and normally looks like a gray speck, but when gorged with blood it is distinctly red in color, hence its name. The mites live in the cracks and crevices of the building, especially on the perches and nearby walls, from which they make nightly raids upon the roosting poultry to suck blood.

The eggs of the mites are laid in the hiding places and require from four to five days to hatch. The length of time for the young to develop to maturity varies according to the supply of food. Mites are most active in warm weather. They will live for at least five months without food in a vacated build-

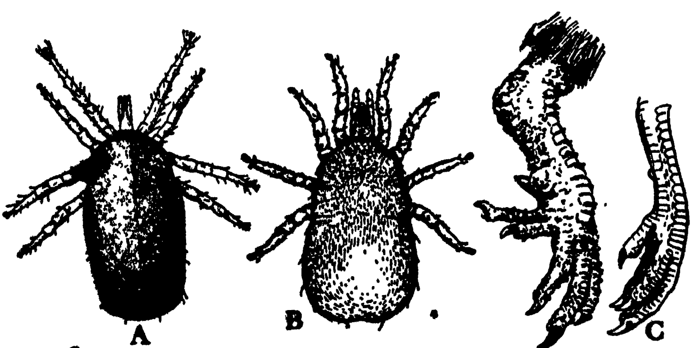


Fig. 186. A, common chicken mite gorged with blood; B, the tropical fowl mite; C, normal leg compared with scaly leg at left. (Cornell University.)

ing, a fact which should be considered when chicks or old stock are placed in old buildings.

If the house is badly infested, all the movable fixtures, boxes, barrels, bags, should either be burned or soaked with some liquid material suitable for the purpose. The nests, dropping boards and floor should be cleaned thoroughly and the entire house sprayed with carbolineum, crude carbolic acid, cresol, creosote or crude oil. Whitewash, with a pint of crude carbolic acid in each gallon of the mixture as a disinfectant, and an ounce of alum to make it stick, makes a good spray material for old buildings where there are many cracks.

Prevention consists in spraying the perches at regular intervals with some wood-preserving material like carbolineum which has an oily base. A number of commercial products on the market are sold specifically as a spray for controlling red mites. Most of these products are satisfactory. Such materials strike into the wood, kill the eggs as well as the adult mites and are effective over a longer period. In warm weather the roosts should always be examined at frequent intervals for evidences of mites.

Scaly-leg mite. Scaly legs are caused by a very small mite scarcely visible without a lens which lives under the scales of the legs and burrows in the skin. Their presence under the scales starts an irritation which results in the formation of a spongy or powdery substance beneath the scales. This raises the scales, giving the legs and toes an enlarged rough appearance. In severe cases the feet bleed and the bird becomes lame.

The scaly-leg mite spreads from bird to bird by contact, consequently the whole flock will soon become contaminated unless something is done to check it. The legs should be dipped in a mixture of ½ pint of kerosene and 1 pint of raw linseed oil. An ointment made from 5 parts of melted vaseline and 1 part of caraway oil and applied warm is considered better. The treatment should be repeated twice at intervals of a week.

Depluming mite. This is a tiny mite similar to the scaly-leg

which attacks the feathers beneath the skin, causing them to break off close to the skin or be shed, leaving the head or back of the bird bare.

The affected birds should be isolated and the oil of caraway ointment already mentioned for scaly-leg applied. One part of flowers of sulfur with four parts of vaseline is used.

Air-sac mite. The air-sac mite is a small, yellow, soft-bodied mite, just large enough to be seen with the naked eye. They are often seen in large numbers in the windpipe, lungs, air-sacs, hollow bones and the peritoneum.

There is no treatment for these mites.

Northern mite. This mite closely resembles the common mite in size, but differs in its habits. It lives and reproduces on the fowl's body and is a bloodsucker. It is, therefore, more serious than the common red mite and unless controlled, the vitality of a flock is soon sapped. Like most mites, it multiplies rapidly, the life cycle from egg to adult being eight to twelve days.

Payne reports excellent results in destroying this mite by the use of nicotine sulfate painted on the perches as for body lice. The affected birds may also be treated by spraying them lightly with 40 per cent nicotine sulphate diluted 1 to 10 with water. Dusting the birds with flowers of sulfur is also effective.

Ticks. Ticks are found in the southern states. Beach and Freeborn [11] describe the parasite as follows: "These parasites are closely related to the mites but are always larger, easily visible to the naked eye and have a thick leathery cuticle or skin. The only tick attacking fowls that is of economic importance is the so-called fowl tick or 'blue bug' (*Argus persicus*). The adult tick is flat, egg shaped in outline, dark brown in color, from ¼ to 7/16 of an inch in length and about half as wide at its widest point. Its habits are essentially like those of the common chicken mite referred to above. The ticks have a remarkable ability to live for long periods without food. Rec-

[11] Univ. Calif. Circ. 8.

ords are available of adult ticks that have fasted for 2½ years."

Ticks lay their eggs in cracks and crevices of the building. After the eggs hatch, the young ticks find their way to the chickens' bodies where they remain until matured. After that the adult tick returns only at night when the birds are on the perches to feed upon the chickens.

Treatment is similar to that for the common mite except that the material used must be very strong as ticks are very resistant. Undiluted carbolineum, or crude carbolic acid, or creosote are probably the best disinfectants to use. The house must be cleaned and sprayed thoroughly. If the birds are badly infested by larvæ taking their first meal, they should be removed to temporary quarters and dipped in a 2 per cent creolin solution or allowed to remain until the ticks become engorged and drop off. The birds can then be returned to the disinfected coop. The period of quarantine should be about ten days.

Preventative measures consist in suspending the perches from the ceiling and spraying both the roosts and neighboring walls regularly with a powerful disinfectant. All new stock brought on the premises should be quarantined for ten days

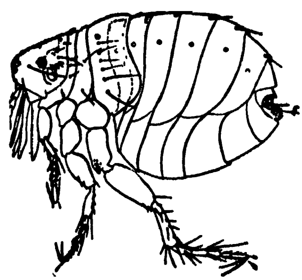


Fig. 187. The common hen flea (Cornell University.)

Fleas (Fig. 187). Fleas are most common in the warmer regions. Beach and Freeborn[12] give the following description of the parasite: "These insects may be distinguished by their dark brown color, three pairs of legs, and their flattened condition. The sticktight flea (*Echidnophaga gallmaceae*), although parasitic on dogs and cats, finds its best host in poultry. This flea remains attached to the host throughout its adult life. In poultry they are generally located about the eyes

[12] Univ. Calif. Circ. 8.

and comb. The eggs laid by these attached females fall to the ground and hatch, or in case the eggs are retained in the burrows or ulcers caused by the attached females, the larvæ upon hatching fall to the ground. These larvæ are tiny white, caterpillar-like organisms with chewing mouth parts. They subsist on the débris or manure on the floors of the houses and yards. When they have become full grown as larvæ they spin a white cocoon in which they change from the larval stage to that of an adult, after which they attach themselves to the skin of their hosts to suck blood. The constant irritation, particularly in spots where they are present in large numbers, together with a slight burrowing activity on the part of the fleas, causes the formation of ulcers so extensive at times that blindness and subsequent death is produced."

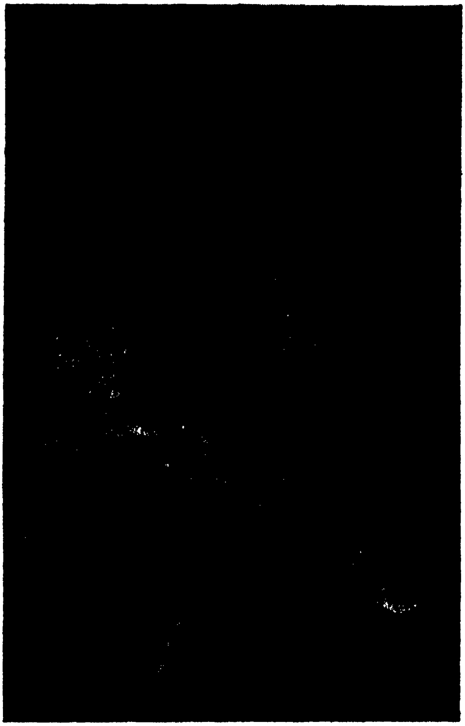


Fig. 188. Spraying outfit for disinfecting poultry-houses

Treatment consists of thoroughly cleaning and disinfecting the floors, nests and side walls as for common mites. Infested birds may be relieved by dipping them in a 2 per cent creolin solution.

All scrapings and litter from infested poultry-houses should

be promptly plowed under to prevent the development of larvæ.

The Florida Agricultural Experiment Station reports excellent results in controlling fleas by dusting sulfur (325 mesh, cheapest dusting grade) about the house, dropping boards, perches, and nests. This treatment was particularly effective in controlling mites and fleas when the sulfurization was extended to the yards. Two pounds of sulfur was applied to 100 square feet of yard space. The birds were confined to treated areas.

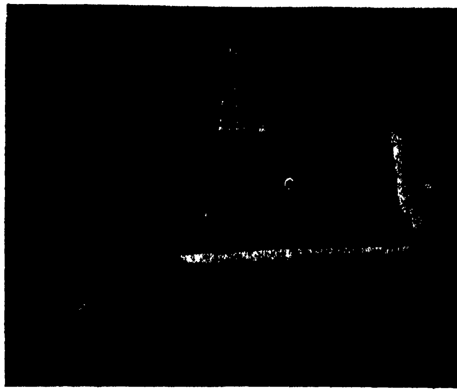


Fig. 189. Cleaning utensils. A, dropping-board scraper B, brush; C, small scraper.

Chiggers. The small chiggers which annoy man, animals, birds, and reptiles in the southern states also infest chickens that run on the land. Chiggers attach themselves in groups on the wings, breast, and neck. Young chickens soon become droopy, refuse to eat, and frequently die in a short time.

Chiggers usually appear some time after warm weather begins and are active until frost. Infestation may be prevented by hatching early and by keeping later-hatched chickens out of grass and weeds. Dusting the chicken ranges with sulfur at the rate of 2 pounds to 100 square feet is helpful. Dusting the young chickens lightly with sulfur also aids in protecting them. Sores caused by the chiggers may be touched lightly with carbolated vaseline or sulfur ointment, see page 484.

Other poultry pests. Bedbugs are found frequently in poultry houses and cause considerable trouble. They are controlled by the use of creosote oil and carbolineum the same as mites and

ticks. The same applies to the Mexican chicken bug or adobe bug found in the arid regions of the southwest.

MISCELLANEOUS DISEASES

Bumblefoot (Fig. 190). Bumblefoot is an abscess or corn on the foot of a fowl. This condition is probably the result of bruising or injury to the feet. It may be caused by the bird jumping from a high perch to a hard floor, by too narrow roosts which force the bird to cling tightly to the perch at night, or by walking on rough stones, cinders or any material that is likely to cut or injure the bottom of the feet.

With a bad case of bumblefoot, the foot is so sore that the bird walks with a limp. When the foot is examined a hot painful swelling is observed on the ball of the foot and between the toes. Usually this is an abscess with a core-like center of cheesy material.

If the abscess has formed a head, it should be lanced, the pus-like material dug out, the wound washed with warm boric acid or a similar disinfectant, tincture of iodine applied and the foot bandaged. The bird can then be returned to the flock until the wound is healed sufficiently to remove the bandage. There will be less loss of blood during the operation if a cord is tightly tied about the leg just above the foot.

High narrow perches, uncovered hard floors, and rough yards should be avoided.

Fig. 190. Bumblefoot.

Crop-bound. "Crop-bound" or impacted crop is a paralyzed or over-distended condition of the crop caused by the swallowing of coarse indigestible materials like long tough grass, straw, and feathers, which clog up the passage from the crop.

The crop is noticed to be distended and pendent, and on handling it will be found to be hard, full and impacted.

Often there is loss of appetite and difficulty in swallowing.

By manipulating the crop it can be determined whether it contains straw and grass, or just grain. Sometimes when it is packed with grain a little oil may be given and the crop massaged to mix it with the contents. The bird is then held head down and an attempt made to work the material out through the gullet. If this fails, an operation is necessary, as follows: First, remove a few feathers on the breast opposite the upper part of the crop. Make an incision about 1½ inches long, being careful to cut the skin where there are no large blood-vessels. Then slide the skin over about an inch and cut into the crop. With a button-hook or the finger remove the contents. Disinfect the parts, sew up the opening into the crop and the outside skin separately. Keep the bird in a pen by itself and feed it sparingly on moist mash until the wound starts to heal.

Egg-bound. This condition is due to failure to pass the egg in the normal manner. This happens frequently with pullets and sometimes with hens. With pullets the cause is the result of an attempt to lay a large egg before sufficient dilation of the oviduct has occurred. It may also be due to inflammation, malformation, stricture, or tumors, which obstruct the passage of the egg.

The hen makes frequent trips to the nest to lay. There is much straining resulting in inflammation and sometimes perlapsus of the oviduct. The bird often assumes a duck-like position. Death may result from exhaustion or bleeding due to having the inflamed parts torn away by other birds in the flock.

If it is evident that the bird cannot pass the egg naturally, some olive oil should be poured into the cloaca, one finger passed carefully inside, and with the other hand pressing on the abdomen outside the egg is forced toward the vent. When the end of the egg is in sight, the shell should be punctured with a nail, broken into pieces and the contents of the egg re-

moved. The parts are then washed out with cold water to reduce inflammation and the bird put into a separate pen.

Frozen combs and wattles. The freezing of combs and wattles, especially of males, occurs quite frequently in the colder parts of the United States. The frosted parts swell, become bluish-red in color and very painful. In severe cases the comb and wattles shrivel and turn black and eventually slough off. Occasionally birds die. When a male bird's comb and wattles are badly frozen, it usually makes him unfit for breeding purposes for a few weeks afterward, or until he has completely regained his vigor.

If discovered in time, the frozen parts can be thawed out with snow or in water, and vaseline applied. This reduces the injury. When the injury is severe, recovery will be hastened by cutting off the frozen parts after they have turned black with a pair of shears. The flow of blood may be checked, if necessary, by searing the wound with a hot iron or the application of a few drops of tincture of ferric chloride or powdered alum.

Freezing can be prevented by *"dubbing."* See Fig. 191-A, B. This consists of removing the comb and wattles when the birds are young. Males may be dubbed when their combs are about ½ inch high. Both the comb and wattles can be cut off close to the head with an ordinary pair of shears. If the operation is done on a warm day in the summer there will be little loss of blood. Usually it is not necessary to treat young birds to stop bleeding. The best time to dub cockerels is while they are on the range. Dubbing is usually not advisable for mature birds, as bleeding is likely to be severe.

Heat prostration. Chickens suffer from over-heating in the summer when buildings or nests are insufficiently ventilated, or there is lack of shade. Over-fat birds or those out of condition are most likely to be overcome. Birds affected by heat collapse or stagger when they walk. Prompt removal to cool comfortable quarters generally results in their recovery.

During extremely hot spells, losses from heat prostration can be prevented by sprinkling the ceiling and inside walls of the pen with a hose every two hours during the day. It is

Fig. 191. Dubbing a Leghorn cockerel about three months of age. A above, removing the comb with shears, B below, cockerels with comb and wattles removed

not advisable to sprinkle prostrated hens with water as this seems to increase the mortality.

Internal layer. The term "internal layer" applies to hens that have the appearance of layers but do not lay any eggs. In

many such hens the ovary may function normally but, due to an abnormality of the oviduct, the yolks may not be able to pass through it or are diverted into the body cavity. In either case, they are usually absorbed. Sometimes, however, inflammation, cysts or tumors may result.

In other less frequent cases the walls of the oviduct become torn, either as the result of vigorous contractions after efforts to expel an abnormally large egg or from inflammation, and this permits the partly formed eggs to escape into the body cavity. On other occasions reverse peristaltic action of the oviduct may force the completely formed eggs back up the oviduct through the funnel-shaped opening near the ovary into the body cavity. Several eggs may thus be deposited in the body cavity, sometimes without apparently seriously affecting the health of the bird.

This condition may be suspected if the adbomen becomes enlarged and hard. Moderate exertion also causes the comb, face and wattles to turn a deep purplish-red because of the pressure on the heart and lungs. Such cases are incurable.

Perosis. Perosis (Fig. 192), slipped tendon or hock disease, is a nutritional deficiency disease affecting bone formation of growing chickens, turkeys and game birds. It is caused by a lack of small amounts of manganese and choline and probably other nutritive factors in the diet. It is found most frequently among young birds which are reared in batteries or in confinement and fed rations of high mineral content.

Fig. 192. Chicken affected by perosis.

The first indication of perosis is a swelling of the hock joints. This is followed by flattening and twisting of the leg bones at the hock. In advanced cases the large tendon slips from

its natural position to the outside of the joint. This increases the enlargement of the hock joint. Affected birds have difficulty in walking. They will not die unless it is impossible for them to secure food or they are pecked or killed by other birds. Usually only one leg is affected and the first symptoms do not appear before the birds are three weeks of age.

Perosis can be largely prevented by feeding 4 ounces of manganese sulfate in each ton of feed, and by avoiding excessive amounts of calcium and phosphorus in the ration. Perosis is seldom seen when the birds have access early in life to pasture and plenty of green food.

Advanced cases of perosis cannot be cured. They should be removed and used for food. Birds in the early stages of perosis may return to normal, if the deficiency in the ration is corrected.

Poisoning. Poisoning may take place when birds eat decomposed animal tissue, certain weed seeds, moldy food, excessive amounts of certain medicinal products, or salt and rose-chafers. Rose-chafers are poisonous to young chickens up to ten weeks of age. Chickens eat them readily and only a few are necessary to cause death. Usually the rose-chafers appear only for a short period early in the summer.

The external symptoms of poisoning are darkened comb, prostration, wry neck and diarrhea. Post-mortem examination shows the inner lining of the crop and intestines to be greatly irritated and inflamed. When poisoning is due to rose-chafers these insects will be found in the crop and gizzard. Poisoning may be suspected when a large number of birds suddenly become sick. It is well to remember, however, that several diseases show similar symptoms. Therefore, it is advisable, unless the cause is plainly evident, to submit specimens for laboratory examination before a final diagnosis is made.

Usually little can be done except to remove the cause. If the disturbance is general, it is a good plan to give the whole flock a dose of epsom salts. Individual birds may be given

castor oil at the rate of one-half to one teaspoonful. (See harmful plants and seeds, page 216.)

Prolapsus of the oviduct. The direct cause of prolapsus has not been definitely determined. Apparently this condition is most likely to occur when the muscles and ligaments of the oviduct become weakened by the strain of laying, with the result that the oviduct and cloaca are everted through the vent. This may result from any one or a combination of the following:

1. Lack of strength and tone of body tissues when birds suddenly start laying heavily after a period of rest, or after continued heavy production.
2. Straining to lay abnormal eggs or to pass an obstruction in the oviduct; or a partial paralysis of the muscles of the oviduct.
3. Infimmation of the oviduct and intestines due to an irritated condition of these parts.

As soon as symptoms of prolapsus are noticed, the bird should be examined. If there is an egg in the passageway, it should be removed. The protruding mass should be washed with warm water, carbolated vaseline applied, and the organ gently pushed back into place. The bird should be placed in a pen by itself and given wet mash for a few days.

Tumors. Tumors are abnormal masses of new tissue of non-inflammatory origin that arise from normal tissue and which perform no useful function.

Tumors are of very common occurrence in poultry, especially in the older birds.

Brunett [18] makes the following observations in regard to tumors:

"Bird tumors usually are found in the body cavity. They may cover the intestines, and may appear in the liver, the spleen, the ovary, and the kidneys. Other parts are occasionally involved. They usually appear as whitish soft masses."

[18] E. L. Brunett, Cornell Extension Bulletin No. 337, p. 59, 1939.

There is no treatment for internal tumors. Some external tumors may be removed satisfactorily by a surgical operation.

"Although the cause of tumors is not known, it has frequently been noticed that they are very common in some flocks and practically unknown in others."

Some investigators now believe that the same filterable agent that causes fowl paralysis also causes certain types of tumors.

When it is possible, it is advisable to secure chicks or stock from strains known to be relatively free from tumors.

VICES OF POULTRY

Egg-eating. When hens are kept indoors for several months without access to a few hours of direct sunlight each day, or a ration containing vitamin D, there is a tendency for the egg-shells to become thin and easily broken in the nests, with egg-eating as the result. This thin condition of the shell may be due to a lack of vitamin D, a factor which the violet rays of the sun and vitamin D products possess, and which are necessary to utilize the calcium in the ration. An insufficient supply of calcium in the daily food may also help to make the egg-shells thin even though vitamin D products are fed or there is access to direct sunlight.

Once egg-eating starts, it is difficult to stop it. Darkening of the nests, plenty of nest material, and frequent gathering of the eggs will help.

The hens should have plenty of calcium in the form of oyster-shells or limestone grit at all times and proper amount of vitamin D in the daily food, if direct sunlight is not available.

Cannibalism. Cannibalism may start in the laying flock following cases of prolapsus or when the vent of a normal hen is red and prominent just after laying. In either case, other birds are attracted by such conditions and picking of the exposed parts begin. Once the bird starts to bleed she is soon

killed. Birds soon acquire the picking habit and are then constantly on the watch for new victims. Cannibalism may also be encouraged by overcrowding, high temperature, improper and insufficient feeding.

Cannibalism seldom appears among pullets on range, but starts as soon as the birds are confined.

It may develop because the birds are less active than they were on the range, and picking seems to be a diversion.

Treatment or prevention of cannibalism is difficult. It is a good thing to look for the ringleaders and remove them. Provide plenty of nests, one to each five birds, and darken them. Keep the birds active by occasionally feeding small amounts of grain in deep litter and by supplying fresh green food, such as beets, cabbage, alfalfa hay and the like, so that the birds can pick at them. Running boards in front of the nests should be avoided; all feed and water platforms should be high enough so that birds standing on the floor cannot pick birds while they are eating or drinking. It is also advisable to provide plenty of dry mash hopper space.

Many poultrymen have found that the feeding of whole oats has been helpful in preventing this trouble. The oats are kept before the birds for at least half a day at a time. In some instances, however, the feeding of oats may not control cannibalism.

When all other things fail, small metal devices known as Specs or Pikgards may be attached to the beaks of the birds (Fig. 193). These have been found to be quite effective in checking cannibalism as well as feather-picking. These devices may be purchased through poultry-supply dealers.

Recent information from the Wisconsin Agricultural Experiment Station indicates that cannibalism may be due to an insufficient amount of salt in the ration. They suggest the addition of one tablespoon of salt to one gallon of water; and that this solution be given as the only drink for half a day. It is then replaced with the regular drinking water. If this does not

Fig. 193. Metal anti-pick device attached through nostrils (Pikgard). (Courtesy of E. L. Brunett, N. Y. State Vet. College.)

check the cannibalism within a day or two, it is repeated after a period of three days. If the trouble is due to a lack of salt this will correct the situation.

Cannibalism among chicks. Cannibalism among chicks is largely caused by lack of something to do, by overcrowded houses, high temperature in the brooder room, lack of feeding space, insufficient feed, close confinement, or a deficiency in the ration. Chicks that are confined are more likely to develop this trouble than those running out-of-doors early in life. It is not necessarily the result of a faulty ration.

Sometimes when the chicks apparently have had good care, cannibalism will break out. In such circumstances do as follows: Remove the victims promptly and paint the injured parts with pine tar, roofing cement, or any commercial "chick-pick." Paint a number of unpicked chicks so that many chicks in the flock will quickly get a taste or smell of the remedy and be repelled by it. This usually prevents further injury. The salt treatment suggested for pullets and hens may be used.

The Washington State Experiment Station reports two methods of controlling cannibalism that have been successful in fattening stations or battery rooms in that state. They consist, first, in using a 60- or 100-watt natural ruby (red) Mazda bulb, glass not inside-frosted; and, second, in spraying the windows with a rich, red-colored lacquer.

In general the best way to prevent cannibalism in chicks is to give them free range or keep them busy by occasionally feeding shredded cabbage, sliced onions, or other green feed. Be sure that they have ample hopper-feeding space and that plenty of feed is always available.

Other factors which seem to assist in controlling cannibalism in chicks are: (1) To cut down the brooding temperature as rapidly as is consistent with the comfort of the chicks. Brooding chicks in close confinement at high temperatures seems to develop the habit of cannibalism rapidly. The use of

a warm and a cool room in confinement brooding is helpful in this respect. (2) To reduce the number in the flock as the birds grow, to prevent crowding.

Feather-picking. Feather-pulling among hens is sometimes checked by applying lard or vaseline mixed with powdered aloes to the feathers. The aloes has a disagreeable taste.

The Massachusetts State College recommend spraying the abdomens of pullets with a mixture of one part pine tar and four parts linseed oil at housing time. They report that repeating this spray every two or three months has helped greatly in reducing feather-picking in flocks in Massachusetts. The use of Specs and Pikgards will also control this vice when other things fail.

POULTRY MANURE

Poultry manure is a valuable by-product of the poultry industry. Many poultry-keepers might add considerably to their income by giving more attention to the storing, treating, and sale of this product.

Amount of manure produced. In one test at the Cornell Experimental Farm, White Leghorn hens in *laying cages* produced at an average yearly rate of 110 pounds of droppings per hen. This figure is the weight of moist droppings as they were scraped from the pens each day. The weight of the same droppings when dried in an oven for 24 hours at 167° F. was 26 pounds.

At the Massachusetts State College, 100 Rhode Island Red hens averaged to produce 19.5 pounds of manure per night for a period of eight months, from November to June. The amount produced varied with the rate of egg production. If the day droppings equaled the night droppings in weight, each bird would produce 143 pounds of fresh droppings in a year. The moisture content of the fresh manure averaged 73 per cent for 30 samples obtained during the eight-month period.

It is probable that each hen produces yearly about 50 to 60 pounds of manure in the condition in which it is usually removed from the laying hens.

Fertilizing value of poultry manure. A ton of fresh poultry manure unmixed with litter and not reinforced with superphosphate, contains about 20 pounds of nitrogen, 16 pounds of available phosphoric acid, and 8 pounds of potash. Poultry manure is 2½ times as rich in nitrogen as barnyard manure, 4 times as high in phosphoric acid, but slightly lower in potash.

Treating poultry manure. To conserve the fertilizing value of stored poultry manure, it should be mixed with sawdust, peat moss, or other fine-textured litter equally absorbent. Scatter the drying material on the dropping boards each day after cleaning, or in the dropping pits every few days. Use 3 pounds of superphosphate daily for each 100 hens, to reinforce the fertilizer value of the manure and keep down odors.

Selling. Treated manure from the droppings board stored in a shed will slowly become dry and bulky. When pulverized with a hammermill it makes an excellent fertilizer for lawns, golf courses, etc. It sells readily in paper sacks where a demand has been created.

XX. Turkeys, Guinea Fowls and Peafowls

ASIDE from the barnyard fowls, comprising various members of the genus Gallus, are other domesticated and semi-tamed birds coming within the range of the poultry-keeper. The remainder of the book is devoted to these animals. Three birds, although not closely related zoölogically, may be discussed together in this chapter—the turkey, the guinea fowl, and the peafowl—because their requirements are similar.

TURKEYS

Turkeys are natives of North America, where they were discovered in 1498. At that time wild turkeys were domesticated by the Aztec Indians of Mexico, and they were soon introduced into several European countries where they have been popular ever since.

Turkey-raising developed first in the New England states and gradually spread with settlers to other sections of the country. Turkey production throughout the United States was confined to small farm flocks for a long time. Commercial production was limited until about 1930 by many factors, the principal one being the control of disease. There has been a pronounced increase in the number of turkeys raised during the past 10 years, and a trend away from small farm flocks to specialized turkey farms where intensive methods of culture are employed. The reasons for the very rapid increase in turkey production during recent years appear to be mainly a more general knowledge and application of improved methods of disease control and improved methods of feeding and incubation.

Varieties of turkeys. Six varieties of turkeys are recognized by the American Poultry Association in its "Standard of Per-

fection." All originated from four wild varieties which ranged over the eastern parts of the United States from Maine to Mexico.

The six varieties are the Bronze (Fig. 194), White Holland, Bourbon Red, Black, Narragansett, and Slate.

The Bronze, White Holland, Bourbon Red and Narragansett varieties are most commonly grown. The Bronze is by far the most popular variety, probably because of its larger size. However, the differences in size between various strains of Bronze are often as great as between varieties. More intensive breeding has been done with this variety, probably because of its popularity. The most recent strain of this variety is the Broad Breasted Bronze. As the name signifies, this strain has a broad breast, but it is also extremely large in body size at maturity.

The White Holland variety has the advantage of white feathering, which makes it easier to dress, as it has no dark pin-feathers.

The weights of the different varieties of turkeys as given in the "Standard of Perfection" are as follows:

TABLE XLV

STANDARD WEIGHTS OF TURKEYS AT VARIOUS AGES

VARIETY	PULLET	HEN	COCKEREL	1-YEAR-OLD COCK	ADULT COCK
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Bronze	16	20	25	33	36
Bourbon Red, Narragansett, White Holland, Black, Slate	14	18	23	30	33

The selection of a variety depends on the individual; but the most popular variety in the community, the market outlet, and the size of bird should be taken into consideration in making the choice.

It is essential to begin with good stock and maintain this quality, to produce market turkeys of the highest quality.

Trading for ordinary stock just to prevent inbreeding is unwise. The best kind of foundation stock comes from a breeder

Fig. 194. Breeding flock of Bronze turkeys on free range. (*U. S. Dept. Agr.*)

who selects and breeds for high livability, early maturity and a desirable body type.

Selection of the breeding stock. Since turkeys are grown for meat, they should be bred for the type which produces meat most efficiently and for the size most in demand. Surveys of consumer demands show that the average consumer wants a bird weighing from 9 to 15 pounds. Restaurants and hotels prefer the heavier birds.

Turkey breeding stock is best selected for meat production when the birds are about 24 to 28 weeks of age and before any are marketed. They should not be selected unless they are well matured at these ages. Turkeys that grow rapidly use feed more efficiently and will be in better flesh at the market age. Rate of growth, therefore, may be judged fairly well by the body weight at 24 to 28 weeks of age. Breeders may set up standards of weight for either of these ages.

Maturity is indicated by uniformly heavy fleshing and relatively few pin-feathers. The best breeders are those that have the most complete fleshing and the fewest pin-feathers at the desired body weight. Medium-sized turkey hens should mature at about 24 to 26 weeks, toms at 26 to 28 weeks.

A good type for a breeder is one that has a body which is

broad, deep, low-set, compact, and well covered with flesh. The breast bone, or keel, should be moderately long, relatively straight, and *parallel* with the back. The shape and length of

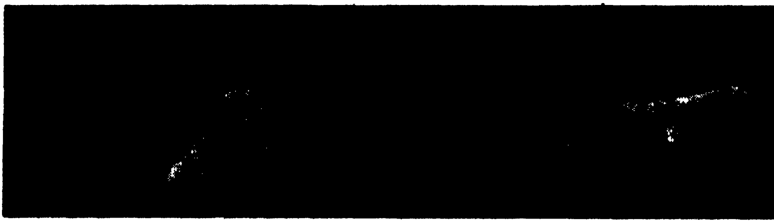


Fig. 195. Birds that have hatchet-shaped or knobbed keels, such as bird at left, should not be used as breeders. (Poultry Dept., Cornell University.)

the keel have an important influence on the appearance of the dressed carcass. Birds that have hatchet-shaped or knobbed keels should not be used as breeders.

The legs should be set wide apart, strong but moderately fine of bone, and not too long. The thighs should be large and plump, and well meated down to the hocks. The eyes should be full and bright, the head short and broad. The bird should be vigorous and active.

Characteristic feather color for the variety should not be neglected, even though it is not related to meat production. It helps to distinguish the different varieties.

Birds selected as breeders should be free from all deformities, particularly crooked breast bones.

Selection by body measurements. Turkey breeders will secure greater uniformity in the selection for body conformation if a minimum weight is set on hens and toms at a certain age, as suggested above, and certain measurements are made in the selection for body conformation in proportion to this weight. The Oklahoma Agricultural Experiment Station has developed a set of tables, based on scientific investigation, for this purpose. The use of this table is explained as follows:[1]

[1] Oklahoma Agricultural Experiment Station, Bulletin 236, 1939.

"These figures are to be used merely as a guide in selecting the superior specimens. The best birds at these ages should have a shorter shank, a longer keel and no greater depth for their weight than that given in the table."

TABLE XLVI

MEASUREMENTS TO BE USED AS A GUIDE IN SELECTING FOR DESIRABLE CONFORMATION IN LIVE TURKEYS

Males, 28 Weeks of Age*				Females, 24 Weeks of Age*			
Weight (Lbs)	Maximum Shank (Inches)	Minimum Keel (Inches)	Maximum Depth (Inches)	Weight (Lbs.)	Maximum Shank (Inches)	Minimum Keel (Inches)	Maximum Depth (Inches)
15	7.0	6.7	8.2	8	5.4	5.3	6.1
16	7.1	6.8	8.4				
17	7.3	7.0	8.5	9	5.7	5.5	6.4
18	7.4	7.1	8.7				
19	7.5	7.2	8.9	10	5.9	5.7	6.6
20	7.7	7.3	9.0	11	6.0	5.9	6.8
21	7.8	7.5	9.2				
22	7.9	7.6	9.3	12	6.2	6.0	7.0
23	8.1	7.7	9.4	13	6.4	6.2	7.2
24	8.2	7.8	9.6				
25	8.3	7.9	9.7	14	6.5	6.3	7.3

* Note: These measurements are applicable only to turkeys at or before the ages specified.

A glance at Table XLVI shows that the weight of the bird and three measurements must be obtained. The weights may be obtained satisfactorily on a milk scale of 30 pounds capacity. No special caliper for measuring is necessary. A machinist's caliper or one that is used in fitting shoes is satisfactory. After weighing the turkey, measure the depth from the front point of the keel to the shoulders just behind the wings. The length of keel is found by measuring from the front to the rear of the keel bone. To measure the length of the shank, bend the shank at right angles to the thigh and bend the toes to the position they are in when the bird is standing. The length of the shank is the distance from the outside of the hock joint to the bottom of the foot pad.

"After measuring a turkey, look at Table XLVI for the

corresponding body weight and compare the measurements on the same line with the measurements obtained.

"The figures in Table XLVI are applicable to any breed, or to small or large strains of turkeys. However, it can be used only for turkeys at or before the ages given; turkeys continue to grow and change shape after these ages. The table is arranged so that turkeys of different sizes may be compared with each other. Males and females of the same proportional size are on the same lines. A tom weighing 20 pounds at 28 weeks of age corresponds to a hen weighing 11 pounds at 24 weeks of age. Thus, after choosing a weight to select for in one sex, the table shows the typical weight for the opposite sex at the ages given."[2]

Breeding methods. There are two methods generally in use which turkey breeders follow in mating their breeding stock. One consists of single matings, where one male is mated with 10 to 20 selected females. This method is followed by the small breeder and by many of the larger commercial breeders. Single male matings are necessary where pedigree breeding and progeny testing are done. The birds in each mating may be confined or may have the use of a range 15 by 200 feet. Two yards of this size are desirable for alternate ranges for each pen. When the breeding pens are adjacent, it is advisable to have solid partitions 3 or 4 feet high between them, or cover the fences with cloth so that the birds cannot see each other. Otherwise, interference between males will result in lowered fertility and unsatisfactory reproduction.

The other method of mating is known as flock or mass mating. In flock matings, from 50 to 150 females are mated to several males. One tom is used for from 10 to 20 females. Usually they are kept on a range, allowing from 75 to 100 birds to an acre. To reduce infertility to a minimum, an alternate group of toms is substituted for those on range twice each week. The reserve toms should be kept in separate pens

[2] West Virginia Agr. Exp. Sta., Circular No. 41, April, 1940.

and out of sight of the breeding flock. Unless pedigree matings are to be made, the alternation of toms should be practiced in single matings the same as in flock matings.

Another method of preventing interference of males is to confine them on the range in individual pens about 6 feet square, with openings just wide enough for the females to enter. By arranging the pens so that the hens have to pass through them to get feed and water, mating without interference is assured. Solid partitions should be provided between pens to prevent fighting.

Most turkey breeders try to avoid close inbreeding. Investigations with turkeys show that close inbreeding (brother-and-sister matings, etc.) lowers hatchability and, if continued, will result in lowered fertility, increased mortality, slower growth and late maturity. For the turkey breeder who does pedigree breeding and progeny testing, inbreeding provides a valuable means, when properly used, of establishing desirable characters in a strain. However, for those who do not care to follow such an intensive program of breeding, outcrossing usually is more satisfactory. To do this, males are purchased from some breeder who has the desired type and are mated to selected females from the buyer's flock. If results are good, more stock can be obtained from the same breeder year after year with little danger of inbreeding. By going continually to the same source for new stock, better uniformity of type is assured. Also, by purchasing eggs or poults the livability, growth, and feathering can be observed, and the danger of introducing disease is reduced.

Breeders who wish to produce their own toms may do so if they have two or more separately mated flocks. The poults from each flock should be identified by wing-bands or by slitting the web between the toes. The best toms in each flock are rotated regularly from flock to flock and mated to the best females in these flocks. This does not eliminate inbreeding entirely, but it prevents the closest form of inbreeding. It will

not be necessary usually to secure new blood for several years, especially if four or more separate matings are maintained.

Cross breeding of varieties has been tried, but the results in fertility, hatchability, livability and growth are not sufficiently superior to outcrossing of strains within a variety to justify its use.

Artificial insemination has been reported as successful in turkey breeding, but, although it has possibilities, thus far it has not been used extensively.

Age of breeding stock. Young well-matured hens and toms usually make the best breeders for market-turkey production. Yearling hens lay earlier in the season and produce more eggs than older birds. Hatchability is generally higher. Young toms are more vigorous and usually give higher fertility than older toms unless the old toms are exceptional individuals. The excessive weight of older toms sometimes results in greater injury to the hens.

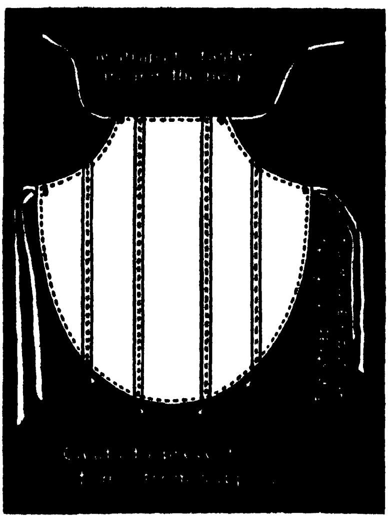


Fig. 196. A blanket. Blankets for the hens prevent serious losses from tears and bruises during the mating season. (Courtesy of E. Y. Smith, Cornell University.)

The breeder who progeny-tests of course must keep breeding stock for several seasons.

Where young breeding stock is used, it eliminates the cost of keeping breeding stock from one season to another.

Preventing injury to hens. To prevent injury to the hens, the toe nails of the toms should be trimmed when they are placed in the breeding yards. Heavy clippers can be used for this purpose. In addition, canvas

saddles can be fastened over the backs of each hen to prevent torn backs. These saddles can be purchased.

Management of the breeding stock. Turkeys can stand ordinary winter weather without shelter of any kind, but during damp cold stormy times some kind of protection should be given. A shed with an open front makes a good roosting place in sections where the winters are severe.

Poles 3 to 5 inches in diameter, or 2-x-4-inch pieces of lumber laid flat, make good roosts for turkeys. They should be about 2 feet apart. About one linear foot of roosting space is allowed for each turkey. Nests should be provided in the houses or in some secluded place in the yards. They should be about 24 inches high, 18 inches wide, 28 inches long, and 10 inches deep, and should contain 8 inches of nest material. A flour or sugar barrel with one head out, laid on its side, makes an excellent nest. It should be blocked to prevent rolling, and a little straw provided for nest material. A china nest-egg makes it more inviting.

In recent years there has been a change from open ranges to fenced yards for turkey breeding stock. This is necessary to prevent all the land from becoming contaminated with the blackhead organism. The yards should be of sufficient size to provide pasture during the growing season. It is desirable to have two yards for each breeding flock, especially for single matings, so that they can be alternated. The fences should be 5 or 6 feet high.

Two experiment stations report as good results with turkey breeding flocks kept in complete confinement as with those on range. Confinement is best where range facilities are limited and sanitation is difficult. About 8 to 10 square feet of floor space should be allowed per bird even though a yard is available.

Trap-nests are necessary if pedigreeing and progeny testing are done. These may be the same as for chickens, except that

they must be larger and located on the floor. One trap-nest should be provided for each three hens.

Turkeys mate when the weather begins to get milder in the

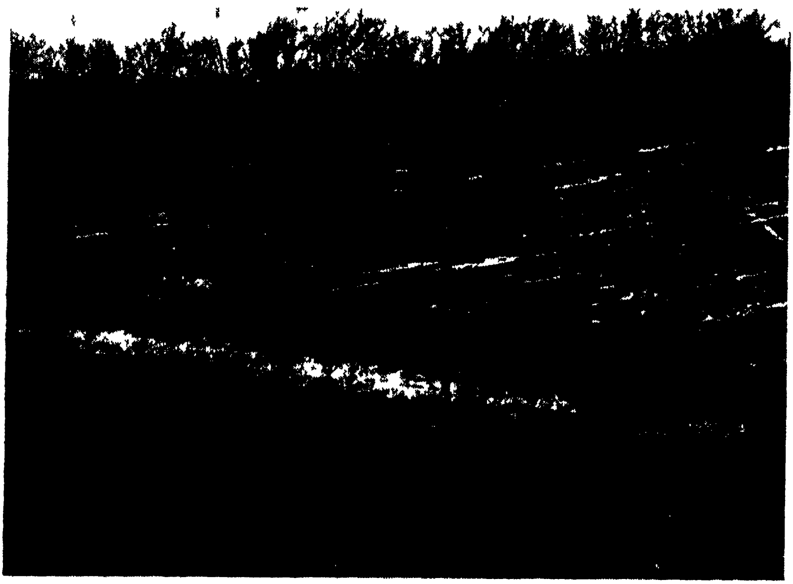


Fig. 197. Turkey breeders on range. Note perches in the open ana shelters for protection on stormy days.

early spring. The hens begin to lay about ten days after mating. Usually, from twelve to twenty eggs are laid in the first clutch before the hen shows any inclination of wanting to set. If the broody condition is promptly checked by placing her in a broody coop for a few days, she will soon lay a second, and even a third or more, clutch of eggs. The number of eggs laid, however, will be less with each succeeding clutch.

Artificial illumination will bring turkeys into production as much as two months before unlighted birds usually begin to lay, and will increase the number of eggs for the season considerably. A 13-hour day (obtained by turning the lights on about 3 hours in the morning or in the morning and evening)

is sufficient. One 50-watt electric light is sufficient for a small pen. (See Chapter XIII for further details on lighting.) The lights should be turned on about a month before eggs are wanted. The males must be placed under lights at the same time as the females, if satisfactory fertility is to be obtained.

Cost of producing turkey hatching eggs. In 1934 the Oregon Agricultural Experiment Station made a survey of forty-five representative turkey-breeding farms to obtain information on the cost of producing hatching eggs. This survey showed that each of the 6,483 turkey hens on these farms averaged to produce 33 eggs at a cost of 13.6 cents per egg.

Hatching turkey eggs. Turkey eggs require twenty-eight days to hatch. The method of incubation is much the same as with chicken eggs. The eggs may be incubated under turkey hens or chicken hens, or in incubators. A turkey hen will cover from eighteen to twenty eggs, a chicken hen from ten to twelve eggs.

The practice of hatching turkey eggs in incubators is replacing the natural method. The eggs are handled in practically the same manner as hen eggs. Artificial incubation has three advantages: first, it helps to prevent blackhead by keeping the poults away from the hens; second, it increases the production of eggs for the season by keeping the hens laying; and third, it simplifies the hatching, especially when many eggs are incubated.

Since turkey eggs are larger than hen eggs, the incubator temperature in still-air incubators should read about one-half degree lower than for hen eggs. A relative humidity of 65 per cent is recommended. Romanoff recommends a slightly lower temperature and humidity after the twenty-fourth day. The operating temperature of still-air incubators varies, depending upon the make of the incubator and the position of the thermometer. (See page 568 for method of determining the correct temperature.)

In forced-draft incubators an incubator temperature of 99.5° F. and a wet-bulb reading of 87–89° should be main-

tained. Machines with separate hatchers may operate the hatcher after the 24th day at a temperature of 99.25° F. and wet-bulb reading of 86°.

Although turkey eggs will hatch fairly well with slight deviations above or below normal, livability after hatching will be seriously affected if the correct incubator temperature is not used.

If the natural method of incubation is followed, the management during the period of incubation is practically the same as for chicken hens. (See Chapter VII, page 123.) When a hen is setting in a field where other turkeys are running, it is best to place a screen of some kind in front of the nest to prevent fighting when other birds try to lay with her. It is a good plan also to watch whether she leaves the nest regularly to feed; if not, take her off every other day.

Turkey hatching eggs should be gathered at least twice a day and promptly placed in a room where the temperature ranges from 50° to 60° F., and the relative humidity is about 70 per cent. They should be turned once a day after the fourth day. Although turkey eggs may hatch fairly well if they have been saved under proper conditions (see Table XLVII) for as long as 28 days, it is better not to hold them longer than 14 days.

TABLE XLVII

EFFECT OF HOLDING TEMPERATURE AND AGE OF EGG ON HATCHABILITY OF TURKEY EGGS [3]

Days Held	Hatchability			
	Temp 36° F. (1931)	Temp. 54° F. (1931)	Temp. 55–60° F. (1930)	Temp 60–75° F. (1929)
1–6	66	71	89	72
7–13	52	65	90	73
14–20	27	75	85	45
21–27	6	67	84	14
28–34	0	61	86	6

[3] Kansas Agr. Exp. Sta., Bulletin 276, 1937.

The normal hatching season for turkeys in the United States extends from March to June. The average production of eggs during this period is from 35 to 40 eggs.

Turkeys hatched later than June seldom thrive as well, or grow to as profitable a market size by Thanksgiving time, as do earlier-hatched ones. It takes about 24 to 28 weeks for a turkey to complete its growth.

Feeding the breeders. The breeding flock should be kept in good condition through the winter if early eggs are desired. A ration of growing mash and whole grain, fed in separate mash and grain troughs and kept before the birds continually, is suitable for this period. About six weeks in advance of the breeding season a breeder mash should be substituted for the growing mash. It is important to begin feeding the breeder mash early so that the birds will be in better condition to pass on to their eggs the nutritive elements that are necessary for hatchability and livability in the poults. Usually, breeder mashes satisfactory for feeding chicken breeding stock are used for turkeys. However, recently there is some evidence to indicate that a little higher protein and vitamin content in turkey rations will give better hatchability. Table XLVIII gives turkey breeder rations suggested by the Poultry Department at Cornell University. They contain 24 per cent protein. The tendency is for the birds to eat much more grain than mash. With the mash mixtures suggested here, they should eat not more than 60 parts grain to 40 parts mash; equal amounts of both is better. Grain consumption can be controlled by covering the feeders a part of the time. Too large an intake of grain may cause a protein or vitamin deficiency of the ration and, consequently, less eggs and poor hatchability. Oyster shell and grit should always be available in separate feeders.

At least one linear foot of trough mash-feeding space, where birds eat from both sides, should be allowed for each 10 turkeys. A similar amount should be provided for grain.

TABLE XLVIII

Turkey Breeder Mashes

Ingredients	Amounts No. I	Amounts No. II
Yellow corn meal	400	400
Corn gluten meal	100	80
Finely ground oats	200	120
Soybean oil meal	200	200
Wheat bran	200	240
Wheat flour midds	200	200
Dried skimmilk	...	80
Dried whey	120	80
Fish meal	200	120
Meat scraps	100	240
Dehydrated alfalfa meal	200	180
Salt	20	20
Finely ground limestone	60	40
Oyster shells	...	...
Manganese sulfate	4 oz.	4 oz.
Total	2,000	2,000
Vitamin D from fish oil or activated animal sterols * when necessary	900 A. O. A. C. units per pound	
Analysis:		
Protein %	23.7	25.5
Calcium %	2.5	2.5
Phosphorus %	1.0	1.3
Vitamin-A units per pound	12,980	11,212
Riboflavin units per pound	2,445	2,613

* Since activated animal sterols are ordinarily not fortified with vitamin A, dehydrated alfalfa containing 75,000 or more units per pound should be used to ensure adequate vitamin A in the ration.

If the vitamin-D potency is expressed in units per gram, multiply it by 454 to obtain the number of units per pound.

Since about equal amounts of mash and grain are fed and the vitamin D is included only in the mash, twice the amount of vitamin-D units is placed in the mash.

To determine the amount of vitamin-D products to add to a ton of mash, see calculations on page 207

TABLE XLIX

Grain Mixtures for Turkeys

Ingredients	Amounts			
	No. 1	No. 2	No. 3	No. 4
	Pounds	*Pounds*	*Pounds*	*Pounds*
Yellow corn (whole or cracked)	50	40	40	40
Wheat	50	40	40	40
Heavy oats	..	20	10	..
Barley	..	..	10	10
Buckwheat	..	..	..	10
Total	100	100	100	100

Brooding. The poults may be brooded by turkey or chicken hens or by artificial brooders. The most general practice is to use artificial means. Brooding with hens may be cheaper and easier when a small number of poults are to be brooded, but with larger numbers the artificial method is necessary to save labor and to prevent blackhead. Even with small numbers, there will be less trouble with blackhead if artificial brooding is used.

Brooding with hens. If the poults are to be brooded with hens, one should prepare a coop of suitable size before the hatch comes off. The coop should have a tight rainproof roof with sides and bottom that will keep out small animals. The front may be made of one-inch-mesh wire or slats to give good ventilation. The coop should be large enough so that a turkey hen can move around comfortably in it.

As soon as the hatch is finished and the poults begin to be active, the mother hen and her family are transferred to the coop. One turkey hen will be able to mother from fifteen to twenty poults.

The hen and poults should be confined to the coop during the first week, moving it to fresh ground at least every other day. On cold or rainy days it is best to keep the hen confined to the coop, allowing the poults to run outside. After the first week, the hen and poults may be let out in the morning if the weather is suitable. Care should be taken to see that the hen and her brood return to the coop at night. If the birds are fed morning and night near the coop, they are very likely to return without any difficulty. However, in case a severe rainstorm comes up suddenly, or the birds fail to come back at the customary time at night, they should be rounded up and brought back safely. The coop will serve as a shelter for the flock until the poults are large enough to roost in the trees. Where the coop is near a tree, rails or poles may be inclined against it, making it easier for the young birds to climb to a roosting place.

Artificial brooding. When turkeys are brooded by artificia means, either the large permanent house with several pens o the colony system is used. Less labor is required to care fo poults in large permanent houses. However, the small hous can be moved to a new location when desired. The houses and equipment in either case are the same as for chickens It is not advisable, however, to brood more than 150 poults in one unit. About one square foot of floor space should be allowed for each poult at the start. Later, more space should be provided, especially if the birds are kept confined. Batteries have been used successfully up to 3 to 4 weeks, in starting poults. About half as many poults should be allowed for each section of a battery as the rated capacity is for chickens. They should be well lighted, especially the first week. Feed and water should be placed inside the battery, as well as on the outside, until the birds use the outside receptacles. This is because turkeys are slower than chicks to become accustomed to their surroundings.

Confinement vs. range. Turkeys may be successfully grown completely in confinement, in yards, or on open range, when

Fig. 198. Turkeys started in colony brooder houses confined to sun porches during the first few weeks.

properly managed. Poults should never be raised with chickens or on land where older turkeys or chickens have ranged or on land where manure from them has been spread within two

Fig. 199. Turkeys reared in confinement. The outside yard has a wire floor.

years. This is because older turkeys or chickens act as carriers of blackhead and parasites. The method of rearing used will depend on the land and equipment available. If the land is contaminated, and clean land is not available, complete confinement is recommended. Even when it is possible to have clean land, it has been found to be good practice to keep the poults confined to houses with sun porches during the first few weeks, as they are most susceptible to disease during this period. Their resistance to disease increases rapidly as they approach maturity.

Range management. In order to have clean ground each year, a land-rotation system should be practiced. The best plan is to have two entirely separate ranges which may be enclosed with permanent or movable fences. Each range can then be used once in two years. They should be seeded pref-

erably with pasture grasses or alfalfa, but rape, sudan grass, rye, soybeans, etc., may be used. The amount of pasture required to furnish sufficient green feed throughout the season of growth will depend on the crop and weather conditions; but it is best to allow an acre for from 100 to 200 birds. It is advisable to rotate the turkeys on the field in use, to reduce the chances of disease, to prevent extermination of the pasture grasses, and to make better use of the pasture.

The Oklahoma Agricultural Experiment Station describes a good way to manage a fenced field for turkeys:[4] "Locate the roosts near the center of the field. Move them three or four times during the season and more often if the weather is wet or the ground becomes fouled with droppings. At first the feed and water containers must be placed within a few yards of the roosts but may be moved away from the roosts a few feet each day or two until they are near the edge of the field. They are then moved weekly. By using this method the turkeys will be kept on clean ground away from the roosts during the day, and at about equal distance from the roosts at all times." As many as 500 turkeys may be allowed to an acre of pasture under favorable conditions, if the field is fenced and the birds are moved to another field weekly. Four or more separate fields are needed when this plan is used, to prevent extermination of the pasture.

Tests show that much less feed will be required per pound of gain in live weight if a range with a good pasture or forage crop is used. Feather-picking and cannibalism occur frequently with confinement rearing, but seldom on range. These advantages are offset to some extent by the additional labor required in range rearing and the expense of growing the forage crops and fencing the range.

Brooding practices. Both wire-covered and litter-covered floors are used in the brooder houses for growing poults. Wire-covered floors need less cleaning and are more sanitary, but

[4] Oklahoma Experiment Station, Bulletin 236.

are more expensive, are unhandy for the caretaker, and are difficult for the poults to walk on at first. Litter-covered floors are usually preferred. Sun porches are desirable, espe-

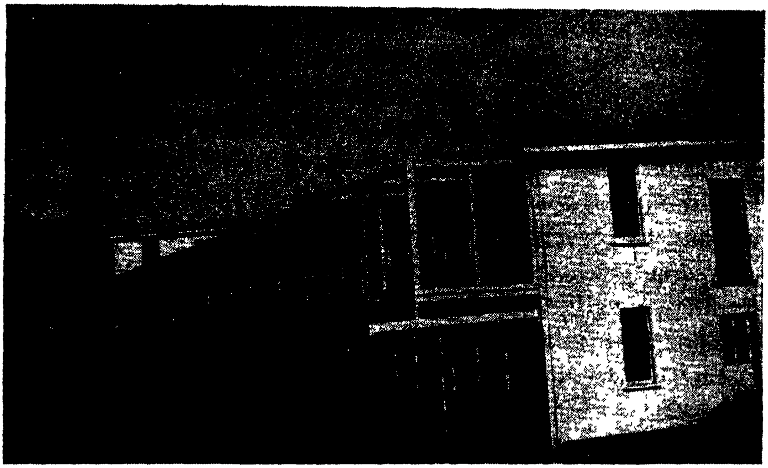


Fig. 200. A permanent brooder house for turkeys with outside yards with wire floors.

cially if the birds are grown in complete confinement. They provide direct sunlight and more floor space. The floor of the sun porch should be made of 1-x-2-inch- or 1-x-4-inch-mesh wire fencing or wooden slats. The area of the sun porch should be about equal to the area of the house. The ground underneath the platforms may be kept more sanitary by applications of superphosphate every few days. This will keep down odors and help to drive away flies. It is common practice for the poults to roost in the house and be fed on the sun porches after the first few weeks. The wire on the sides of the sun porch should have long narrow openings for free access to feed and water, if the feeders and waterers are hung on the outside of the porches.

Feeders and water fountains similar to those used for chickens (see page 167) may be used for turkeys. Enough trough-feeder space should be provided to permit about half of

the birds to eat at one time during the first four-weeks period.

The temperature under the hover of the brooder should be about 95° F. at two inches above the litter at the edge of the hover, or warm enough so that the poults appear comfortable. Poults are more susceptible to crowding than chickens; therefore, careful attention must be given to this detail. The temperature should be reduced as rapidly as is consistent with the comfort of the birds. At three or four weeks of age, poults should be taught to roost. Roosts of 1-x-3-inch boards laid flat should be built about a foot from the floor, to encourage roosting and to prevent crowding.

Feeding practices. There are many rations and methods of feeding young turkeys that have been used successfully. Many changes have taken place in recent years in the rations and methods of feeding poults as well as chickens. This has made it possible to secure better growth with more simple feeding practices. The rations and method given here for feeding poults are recommended by the Poultry Department at Cornell University. They are much the same as those used for chickens, except that they carry more protein and vitamins. Turkeys grow more rapidly than chickens, and therefore their requirements are greater.

The poults should be given feed and water before they are 36 hours old, or as soon as they are placed in the brooder house. Early feeding lessens the danger of the poults' eating litter. Poults do not learn to eat and drink readily; consequently, everything must be done for their encouragement. Dip their beaks in the water and in the mash. Keep the trough feeders level full of mash for the first few days. Place mash on newspapers or egg-case flats, and feed often. A little grit may be mixed with the mash. After two or three days, when the poults learn to eat from the feeders, no more mash is fed on flats or newspapers. Some cover the floor of the pen with newspapers for the first few days, and renew them daily. This prevents the poults from eating litter which may cause crop

impaction. The room should be kept comfortable so that the poults will leave the hover to eat.

The starting mash is fed without grain for the first six weeks, and with grain for the second six weeks.

The growing mash is fed from the twelfth week until the birds are marketed. The starting and growing rations in Table L are complete for birds in confinement. No special rations are necessary to fatten turkeys.

For grain mixtures for young turkeys, see Table XLIX.

TABLE L

STARTING AND GROWING RATIONS FOR TURKEYS

Ingredients	Starting Mashes				Growing Mashes		
	Regular Starters			Grower Concentrate	Regular Growers		Grower Concentrate
	No. 1	No. 2	No. 3		No. 1	No. 2	
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Yellow corn meal	24	20	25	See note No. 2 before using.	30	30.5	See note No. 3 before using.
Ground heavy oats	5	10	10		5	10	
Soybean oil meal	10	10	10	30	15	12	36
Wheat bran	15	15	10		12	12.5	4
Wheat flour midds	15	15	15		15	15	
Dried skimmilk			5				
Dried whey	5	5		12	3	2	6
Fish meal	10	5	10	20			
Meat scrap	6	10	6	22	10	10	30
Dehydrated alfalfa meal	8	7.5	7	12	8	5	15
Ground limestone	1.5	1.5	1.5	3	2	2	6
Salt	.5	.5	5	1	1	1	3
Manganese sulfate	¼ oz.	¼ oz.	¼ oz.	¼ oz.	¼ oz.	¼ oz.	¼ oz.
Vitamin-D product	See note No. 1	See note No. 1	See note No. 1	See note No. 1	See note No. 1	See note No. 1	See note No. 1
Total	100	99 5	100	100	101	100	100
Analysis:							
Protein %	23.8	23.5	24.5	41 4	21.8	20.5	36.8
Calcium %	1.9	2.	1.9	2.6	1.8	2.	5.20
Phosphorus %	1	1	1.1	1.8	.9	.9	1.55
Vitamin A per 100 grams	1852	1720	1651	2520	1686	1272	5150
Riboflavin per 100 grams	528	434	476	845	412	330	716

Note No. 1: When birds are in confinement, 900 A. O. A. C. units of vitamin D per pound of feed should be added. No D is needed if birds are on range.

About twice as much vitamin D should be used in the starter concentrate as in regular starter mashes.

If the vitamin-D potency is expressed in units per gram, multiply it by 454 to obtain the number of units per pound.

To determine the amount of vitamin-D product to add to a ton of mash, see calculations on page 207.

Note No. 2: Two hundred pounds of the starter concentrate mixed with 300 pounds of ground grains are equivalent to 500 pounds of the regular starter mashes. It may be economical to use the concentrate when home-grown grains are available.

Note No. 3: One hundred pounds of the grower concentrate mixed with 200 pounds of ground grain are equivalent to 300 pounds of the regular grower mashes.

Management of growing turkeys. When poults are started in confinement and grown to maturity on range, it is customary to let them out on the land when they are from 8 to 10 weeks of age, depending on the season and weather conditions. If the poults are moved from permanent brooders, they can be placed in range shelters until they are inclined to roost in the open. Round poles about 3 to 4 inches in diameter make the best roosts. They should be not less than 20 inches apart, and one foot of roosting space should be allowed to each bird. Narrow roosts increase the number of crooked breast bones. The roosts should be placed on saw horses, frames, or barrels so that they can be moved easily. If permanently located, the ground underneath should be screened to keep the birds out of the droppings. The turkeys need shade in hot weather, and, if trees are not available, artificial shade should be provided.

One linear foot of trough-feeder space and one-half foot of grain-feeder space are adequate for five turkeys during the latter half of the growing period. A covered trough feeder 6 feet long, 8 inches deep, and 10 inches wide, is satisfactory. A 1- to 2-inch lip on each side of the feeder on the inside prevents the birds from "billing" out the feed. A large smooth wire above each feeder tends to lessen picking, as it provides something for the turkey to wipe its beak on besides the shoulders of its fellows.

If cannibalism or feather-picking develops, it can be checked among birds over 12 weeks of age by inserting a pig ring under the upper beak and through the nostrils and clinching it with a pair of pliers. Complete closing of the beak is prevented. Other picking controlls are the same as for chickens.

Where losses from theft are troublesome, it may be desirable to tattoo a brand on the web of the wing. Such markings are helpful in identifying stolen birds.

Growing turkeys sometimes become frightened by noises or prowling animals at night, and stampede, causing severe losses. Night lights tend to prevent this.

Feed consumption and growth. Growth and fleshing at market time depend upon the breeding and management of the flock. With any strain or variety, feeding is a very important part

Fig. 201. Range shelters and grass range for turkeys started in confinement.

of the management. Turkeys that are well fed during the entire period of growth usually make more economic gains than do birds that have to range for their feed until just before marketing. However, combining good pasture with full feeding of an adequate ration will reduce the amount of feed consumed as compared with birds grown in confinement or on bare yards. At the West Virginia Agricultural Experiment Station,[5] growing the turkeys on wire increased the average feed consumption from 15 to 17 per cent as compared with growing the birds on a fenced range planted to rye, oats, and soybeans. The feed required to produce one pound of live weight on range (8 to 28 weeks) was about a pound less than for a similar group in confinement.

Table LI gives typical growth rates for turkeys, as well as feed consumption. Both these factors vary with the strain and variety.

Fattening. No attempt is made by most commercial turkey growers to feed a special fattening ration. It has been found

[5] West Virginia Agricultural Experiment Station, Circular 41, 1940.

that, with turkeys as with chickens, if they receive an adequate and complete ration during the growing period, special fattening methods are unnecessary. The only occasion when such

TABLE LI

AVERAGE GROWTH, FEED CONSUMPTION, AND FEED PER POUND OF GAIN PER BIRD BY FOUR-WEEK PERIODS OF BRONZE, BOURBON REDS, AND CROSSES OF THESE VARIETIES, AT THE WEST VIRGINIA EXPERIMENT STATION [6]

WEEKS	1–4	5–8	9–12	13–16	17–20	21–24	25–28
Ave. live wt. in lbs. 86 males	0.88	3.06	5.39	8.22	12.07	15.99	20.02
16 females	0.76	2.45	4.16	6.14	8.24	10.29	11.39
Pounds feed per turkey mash	1.37	4.72	8.44	9.05	10.08	8.22	4.63
grain	...	...	...	.91	3.08	8.67	14.70
total	1.37	4.72	8.44	9.96	13.16	16.89	19.33
Pounds feed per turkey to date	1.37	6.09	14.53	24.49	37.65	54.54	73.87
Pounds of feed per lb. gain	1.92	2.50	4.11	4.08	4.29	5.43	7.00

methods might be used is when the birds are given unlimited range with little feed, and they are not in good flesh as marketing time approaches. In such cases, fattening should start at least six weeks before marketing.

Marketing turkeys. Turkeys are sold alive or dressed, depending on the nearness to good markets. In the southern and western parts of the United States they are usually sold alive to dealers. In the eastern and northern sections the producer more often dresses the birds for market.

When turkeys are dressed, they are first hung up by the feet and then stuck in the mouth with a sharp knife by the same method in use in sticking chickens (see Chapter XV).

The feathers may be removed by scalding, semi-scalding, or dry-picking. The wax method may also be used to finish

[6] West Virginia Agr. Exp. Sta., Circular 41, 1940. The birds were confined until the eighth week and then had pasture. The birds were well fed on range.

the dressing. Dry-picking is preferred, as the carcass looks more attractive and keeps better. The feathers are also in better condition for marketing. However, semi-scalding is faster, and, if properly done, the appearance is about the same as that of dry-picked birds. Waxing gives the carcass a nice finish. Dressing turkeys requires considerable skill, as the skin, being tender, is likely to tear, spoiling the appearance of the bird. In full-dressing turkeys it is quite important to remove the leg tendons. This makes the meat on the thighs much more edible. Commercial devices can be purchased for removing the tendons.

Dressing shrinkages. Over-night starving will usually result in a weight loss of from 3 to 3.5 per cent. The dressing loss of blood and feathers is usually between 9 and 10 per cent. The combined dressing and drawing loss is between 23 and 24 per cent of the live weight when the turkeys are well starved. These losses, together with the cost of dressing, should be considered in determining the price of dressed turkeys. Whether the producer sells his turkeys alive or dressed will depend on the labor available, the equipment, the price, and nearness to markets.

Grades of dressed turkeys. Tentative U. S. grades for dressed turkeys are: U. S. Special, or Grade AA; U. S. Prime, or Grade A; U. S. Choice, or Grade B; and U. S. Commercial, or Grade C. They resemble similar grades for chickens.

Diseases of turkeys. As has been stated earlier in this chapter, turkey-growing has increased rapidly in recent years largely because a better means of controlling disease has been found. This consists principally in keeping turkeys away from chickens and growing the young birds in confinement or on a rotated range.

Blackhead in turkeys. Blackhead is probably the most serious disease affecting turkeys. It is an infectious disease, principally of young turkeys between the ages of six weeks and four months. The causal germ or parasite is a low form of animal

life, consisting of only a single cell and known as a protozoan. According to Tyzzer:[7] "These parasites are somewhat rounded organisms varying in size but usually slightly larger than blood corpuscles. They occur in great numbers, and the diseased tissues are literally packed with them, like a honey-comb with young bees. They multiply very rapidly. Apparently the parasite enters the turkey by way of the gut with the food or water, and under favorable conditions invades the wall of the cecum and proceeds to multiply. Many of the organisms penetrate the veins of the ceca and are then swept in the blood current to the liver. As the vein divides in the liver into numerous small branches or capillaries these organisms lodge there, as they are too large to pass through the smallest capillaries. They then begin to multiply, invade the liver tissue, and produce the spots already mentioned which are so characteristic of the disease."

It has been found that the disease is not readily transmitted directly, if at all, from sick to healthy birds, although soil on which chickens or turkeys have run for a time may harbor the parasite and be a menace. The manner of transmitting the parasites was more or less of a mystery until Graybill and Smith[8] found that by feeding young turkeys the fully developed eggs of the caecum-worm, which is common in chickens and turkeys, blackhead could almost always be produced. The theory is that the worms, by causing an injury to the walls of the intestine, permit the blackhead parasite to enter the tissues. It is possible that other factors yet undiscovered may have the same result.

The bird becomes increasingly inactive, with no inclination to eat. Later it stands for long periods with the head drawn in, the eyes closed, and the tail and wings drooping. The head takes on a somewhat bluish color. The bird may bury its head in the feathers of the back. There may be a yellowish diarrhea.

[7] *Journal of Experimental Medicine*, 31, p. 647, 1920.
[8] Massachusetts Department of Agriculture, Bulletin 15

Post-morten examination shows the caeca to be enlarged and filled with cheesy material. The liver is covered with spots varying in color from grayish-white to yellow.

There is no cure for blackhead. The best means of control is by prevention, which has already been described. The adoption of the rotation or the confinement method of rearing will help in solving the blackhead problem.

Trichomoneosis is one of the newer diseases of turkeys. It is similar to coccidiosis. Deficiency of vitamin A is thought to be a contributing cause. The disease affects poults from 6 to 10 weeks of age. Symptoms consist of listlessness, and yellow, foamy, and semi-liquid droppings.

The treatment for colds, roup, chicken-pox, impaction of the crop, lice and mites, and pullorum disease, is the same as for chickens (see Chapter XIX).

GUINEA FOWLS

The guinea fowl (Fig. 202) is a native of Africa and is more or less of a game bird. Although they are commonly kept on farms, these birds have never become thoroughly domesticated. They may roost with the chickens at night and eat with them, but they prefer to roam in the fields by themselves during the day where they obtain a large portion of their food. The young, if left to themselves for the first few weeks, live almost entirely on insects.

Guineas are said to drive away hawks and are kept on many farms for this purpose. They become very much excited at the approach of a hawk and announce it by shrill cries.

There are three varieties of guineas: Pearl, White, and Lavender. The Pearl is the most commonly kept.

The sex of guineas is difficult to distinguish, even when they are full grown (Fig. 202). "A good way to discover the sex of a bird is to shut it in a coop out of sight from its mates and note its call. If a female, the call will sound like 'buckwheat.' The male's call is a short 'chit, chit,' followed by a harsh noise

like a buzz saw."[9] The males also have a larger helmet and wattles, and coarser head furnishings.

Incubation and brooding. It is customary to incubate guinea eggs under hens, but guinea hens, turkey hens, or incubators

Fig. 202. Left, male Guinea fowl. Right, female. (U. S. Dept. Agr.)

can be used. Fourteen eggs are usually placed under a guinea hen, eighteen under a hen, and twenty-four under a turkey hen. The period of incubation is twenty-eight days.

Guineas are inclined to mate in pairs, although one male may be mated with three or four hens. They often produce twenty to thirty eggs in the spring, before they go broody. Given their freedom, they generally hide their nests.

Usually, it is not practical to brood guineas artificially because they require free ranges to grow thriftily. Common hens make very good mothers for young guinea chicks. The hen

[9] B. J. Dodge, "The Poultry Industry in New York State," Bulletin 134.

should be confined on rainy days or when there is a heavy dew, to prevent the chicks from getting wet or chilled by running after the hen through the wet grass. Guineas may be fed the same feed as chickens.

Marketing. In preparing guineas for market, the birds are bled but the feathers are usually left unplucked. They are sold in the market by the pair, and vary in size from one to three pounds each.

They are often considered a great delicacy and are sometimes used as a substitute for partridges.

PEAFOWLS

Peafowls are natives of the East Indies, where they are still found in the wild state. In North America they are kept for ornamental purposes in public parks and on private estates.

Peafowls are noted for their remarkable feathering and proud carriage. The tail and train of the male is very beautiful when spread like a fan above his head. The dignity and majesty with which the male displays himself when pleased or in the sight of his females, is expressed by the old saying, "proud as a peacock."

Management. One peacock is usually mated to five peahens. The hens begin to lay during their second year and usually lay five or more eggs in a season.

The eggs may be incubated under hens or artificially. The period of incubation is twenty-eight to thirty days. Peachicks may be brooded with hens or artificially.

According to "The Poultry Book": "The young are easily reared, especially on a dry, fertile soil, where the peahen can have the shelter and range of a shaw, hedgerow, or wood, as well as pasture land. The peachicks will thrive on the same kind of food as young turkeys. When grown, they should have a variety of grain, but about the breeding season more barley, which has a tendency to make them salacious and to increase the fertility of their eggs, as well as the number. The young

keep with the old birds throughout the year, and are seldom driven off until the next breeding season. The peacock does not obtain his full adornment until the second year, and is at his best in the fourth, fifth and sixth."

Peafowl are long-lived birds, some living for twenty years or more. They are very hardy, and, except in cold wet weather, require no special shelter.

XXI. Ducks, Geese and Swans

THE web-footed poultry, indicating a water habitat, may be assembled in one chapter, inasmuch as they are more or less associated in their requirements. These classes are very distinct, however, in their zoölogical or natural history attributes.

DUCKS

Ducks are kept primarily for meat purposes. They are especially adapted for this on account of the rapidity of their growth, hardiness and ease in handling. A young Pekin duck, when properly grown, should weigh between five and six pounds at ten to twelve weeks of age.

Duck-raising, as a business, is limited; for the demand for duck meat is not as steady, or its popularity as great, as for chicken.

Before undertaking to raise many ducks, the possibilities of disposing of the finished product should be considered. Summer resorts and large cities with a foreign population make the best markets.

Breeds of ducks. Eleven standard breeds of ducks are listed in the American Standard of Perfection. These breeds may be divided into three groups: (1) The meat class, including the Pekin, Aylesbury, Muscovy, Rouen, Cayuga, Buff and Swedish; (2) the egg class which includes the Indian Runner and Khaki Campbell; and (3) the ornamental class composed of the Call, the Crested White, and the Black East India. With the exception of the Muscovy, all these breeds are said to have originated from the Mallard or wild duck.

The Pekin, Muscovy and Rouen are the most popular meat

breeds. The Pekin, which came originally from China, easily out-classes the others in popularity as a meat-producer. It is kept almost exclusively by commercial duck-farmers throughout the United States and is a great favorite on general farms.

Pekin ducks are distinguished by a creamy-white plumage, a long broad and deep body, with a full breast. The skin is yellow and the shanks, toes and bill are reddish-orange color. The standard weights of the mature drake and duck are 9 and 8 pounds respectively. This breed is hardy, lays well, grows rapidly and is docile.

The Aylesbury is similar to the Pekin in color and size but is not as popular in North America.

Muscovy ducks (Fig. 203) are poor layers, vary in size

Fig. 203. White Muscovy ducks.

according to the sex, the drake being much larger than the duck. Being good fliers they are less docile.

There are three varieties of Indian Runner ducks; the Fawn and White, the White, and the Penciled. They are much smaller than the meat breeds. The standard weight of the drake is 4½ pounds and the duck, 4 pounds. Indian Runner ducks have long narrow bodies and full breasts. They carry the body in a very upright position. They have the

reputation of laying the best of any of the breeds of ducks and are also said to equal any of the breeds of chickens in this respect. Their eggs are of good size and white.

The ornamental breeds are kept almost entirely for exhibition purposes.

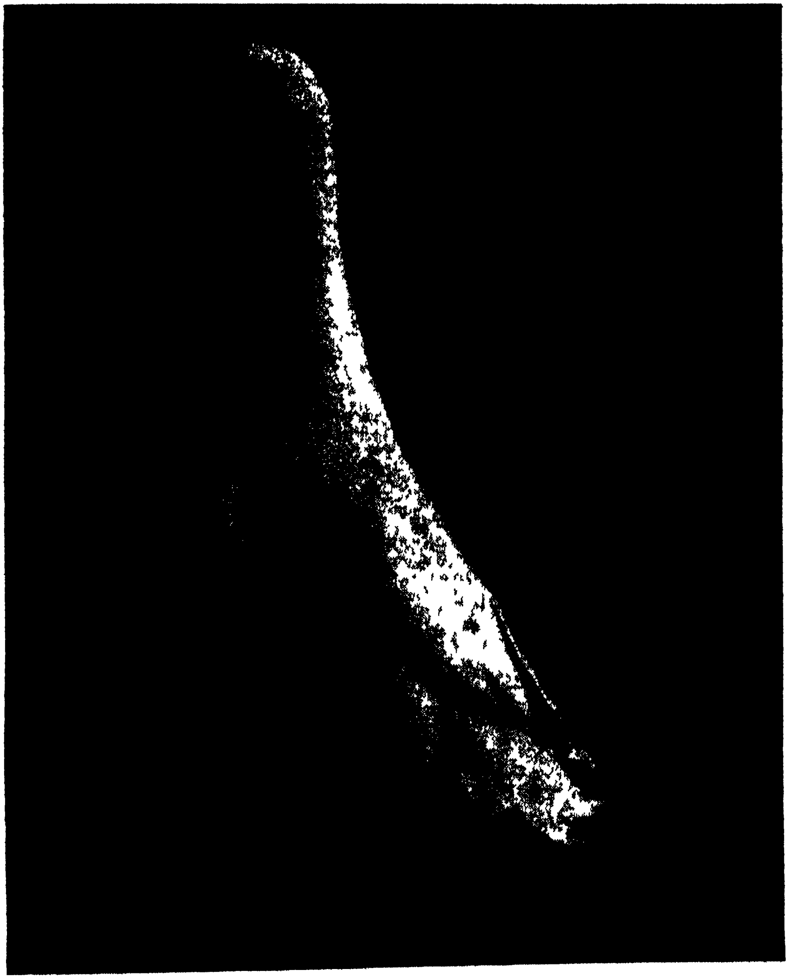


Fig. 204. White Indian Runner drake.

TABLE LII

Breeds and Varieties of Ducks

Breed	Variety	Standard Weight				Weight of Eggs	Color of Eggs
		Drake		Duck			
		Old	Young	Old	Young		
		Pounds				Ounces	
Pekin......	White.........	9	8	8	7	40	White or bluish green tint
Aylesbury..	White.........	9	8	8	7	40	White or greenish white
Rouen.....	Colored........	9	8	8	7	40 to 45	Pale green or bluish green or white
Cayuga....	Black.........	8	7	7	6	35 to 40	Black to bluish green
Call *......	Gray..........	..	..	..	..	16 to 24	White to green
	....	..	..	..	..	16 to 24	
East India *	Black.........	..	..	..	..	16 to 24	Black to bluish green
Muscovy...	Colored........	10	8	7	6	48 to 52	White to greenish cream
	White.........	10	8	7	6	48 to 52	
Swedish....	Blue..........	8	6½	7	5½	....	White or pale blue
Buff.......	Buff..........	8	7	7	6	....	White
Crested....	White.........	7	6	6	5	....	White to green
	Fawn and white	4½	4	4	3½	32	White and creamy white
Runner.....	White.........	4½	4	4	3½	32	White, creamy white
	Penciled.......	4½	4	4	3½	32	White, creamy white
Khaki Campbell †.	Brown or warm khaki color...	4½	4	4	..	31	White
Mallard †...	Colored........	½ to 3	..	1½ to 2½	..	26 to 32	Bluish green, sometimes mottled

* There is no standard weight for these breeds, but the drakes weigh from 2½ to 3 pounds; ducks from 2 to 2½ pounds.

† Not given in *American Standard of Perfection.*

Equipment and location for growing ducks. Ducks do best on sandy soil. The land should slope gently to insure better drainage and sanitation. A slow running stream is desirable for the breeders, as the fertility of the eggs is usually better when they have access to water. If many ducks are kept, good facilities for handling and disposing of them must be considered.

On a large duck-farm where ducks are grown for meat purposes, there is a building for the incubators; several brooder-houses, some with hot-water brooder systems; a house for the breeders; a killing house with facilities for heating water and chilling dressed ducks; and a building for feed storage and mixing. Owing to the fact that all feed for ducks is given in a moist condition, considerable feed-mixing machinery is neces-

sary. Frequently, small trucks on elevated tracks carry mash and other supplies through all the houses and yards. Running water is provided in all the buildings. From 5,000 to 8,000 growing ducks are kept on one acre of land.

A low shed-type building with a cement floor covered with sand and straw or a sandy floor covered with straw, with glass sash and muslin-covered windows in front for abundant light and ventilation, makes a good house for the breeders. About 4 or 5 square feet of floor space is allowed for each duck.

Any type of artificial brooder that can be used successfully

Fig. 205 A flock of pekin ducks on a Long Island duck farm. The soil is sandy and the yard slopes down to the water.

for chickens is suitable for ducks. The size of the brooding outfit will depend on the number of ducks to be raised. On the large farms, hot-water systems are installed almost exclusively.

Selection and management of the breeding flock. When breeding for meat purposes, the breeders are selected at the time of marketing the "green" ducks. Only birds of the heaviest, most vigorous and uniform type should be selected.[1] They should have broad full breasts, a deep keel, broad long backs,

[1] This applies particularly to white Pekin ducks

and medium to large heads. The drake is a little coarser about the head, has a high pitched voice, stands a little more erect than the duck, and has a distinct curl in the tail-feathers. Watery eyes are usually considered an indication of poor vigor. By continually selecting the largest birds as breeders, not only the size but the rapidity of growth can be improved considerably. Constitutional vigor and size are very necessary in successful duck-raising.

The type of the laying duck is much the same as that of the meat duck, except that the laying duck is smaller and more refined, and usually stands more erect. The best layers are small-boned, with sharp, fine heads. They are active and have bright, prominent eyes set high in the skull. Where possible, both ducks and drakes should come from pedigreed stock. This makes it necessary to trapnest the breeders and to pedigree hatch the ducklings the same as is done with hens.

From five to eight ducks are mated to each drake, starting with the lesser number in cold weather, and increasing as the season advances and the weather becomes warm. The breeding flock may be of any size up to several hundred birds, as drakes seldom fight or bother each other. No nests are necessary, for ducks usually drop their eggs about the floor of the house or yard. Most of the laying is done very early in the morning, consequently the work of gathering the eggs is made much easier by confining the ducks to the house until nine or ten o'clock in the forenoon. Also, if they have access to a pond or stream early in the day, they may lay in the water and some eggs may be lost. The average Pekin duck lays about 100 eggs during the season of laying. Duck-farmers usually dispose of the old ducks after one season as breeders. Drakes may be used for two years.

Feeding breeding ducks. On the large farms where ducks are kept for meat purposes, the breeding ducks and drakes are selected during the summer months and are placed in separate pens. From that time until the breeding season they are

fed a ration which will keep them in condition without inducing them to lay.

Rations for layers and breeders. The rations for laying ducks are similar to those for hens. The breeders should have a breeder ration. The mash part of the ration is moistened, and the ducks are given all the wet mash they will eat morning and night. This wet mash should be neither too crumbly nor too wet, but of such a consistency that it will hold together when squeezed with the hand or, if dropped, will fall apart in lumps. A mixture of grains is usually fed in addition to wet mash. In England it is customary to feed laying ducks the hard grain in the water trough. About two parts of mash are fed to one part of grain. Oyster shell or high-grade limestone grit should be supplied to provide calcium for egg-shell formation. In addition, granite grit or gravel may be available in each pen.

In Table LIII and Table LIV, mash and grain mixtures are given for the egg and meat type of ducks kept as breeders. Mash mixtures suitable for ducks kept only for egg production also are given.

The Harper Adams Agricultural College advocates the following method of feeding laying ducks when grain and mash are used.

The first feed is given when the ducks are being released from the trapnests. This consists of 1 ounce of grain per duck, given in the water trough. The second feed, given at 11 A.M., is wet mash, the quantity allowed being rather less than one-half of their total daily mash ration. The third feed, given in the afternoon, is the rest of the mash, and also 1 ounce of grain placed in the water trough as in the morning. Each duck, therefore, receives about 2 ounces of grain and 4 ounces of mash daily.

Artificial lights are used to some extent to increase the egg production in winter.

Incubation of duck eggs. The period of incubation for duck

TABLE LIII

Rations for Laying and Breeder Ducks

Ingredients	Layer Rations: Fed at the rate of 2 parts of mash plus 1 part of grain				Breeder Rations: Fed grain at rate of 2 parts of mash and 1 part of grain		
	1	2	3	4	1	2	3
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Yellow cornmeal.....	500	475	475	450	425	450	400
Wheat bran.........	300	300	300	300	300	300	300
Wheat standard middlings.......... ..	200	200	200	200	200	200	200
Wheat red dog flour..	300	300	300	300	300	300	300
Ground oats, low fiber	200	200	200	200	200	200	200
Soybean meal	150	150	150	150	150	150	150
Meat scrap (55 per cent protein)*	150	100	125	150	75	100	150
Dehydrated alfalfa meal (17 per cent protein)...	120	120	120	120	120	120	120
Dried skimmilk......	...	50	...	...	150	...	...
Dried buttermilk.....	...	...	50	...	...	100	...
Dried whey.........	...	...	..	50	...	...	100
Pulverized limestone.	70	70	70	70	70	70	70
Salt...............	10	10	10	10	10	10	10
Vitamin D from fish oil, feeding oil, or activated animal sterols A. O. A. C. units per pound†...	650	650	650	650	650	650	650
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Protein, calculated.	18.1	18.2	18.1	18.2	18.3	18.1	18.2

* Fish meal may be substituted entirely, or in part, for meat scrap.
† Vitamin D may be omitted from the mash when the ducks run outdoors daily.

TABLE LIV

Grain Mixtures for Ducks

Ingredients	Modifications				
	1	2	3	4	5
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Cracked yellow corn............	50	65	40	40	40
Wheat......................	50	35	40	40	40
Heavy oats..................	..	..	20	10	10
Barley......................	..	..	..	10	..
Buckwheat..	..	..	..	..	10

eggs is 28 days, with the exception of the Muscovy breed which requires from 33 to 35 days. Duck eggs may be hatched either naturally or artificially. Since the Pekin and Runner breeds of ducks are essentially non-broody, it is necessary to use artificial means of hatching or to resort to hens. If only a few ducks are to be reared, the hen is best. The average hen covers from nine to eleven eggs, depending on the season of the year. Ducks usually make unsatisfactory mothers, with the possible exception of the Muscovy breed.

Duck eggs can be hatched successfully in either the still-air or agitated-air incubator.

The same general principles govern the artificial hatching of both duck and hen eggs, but a slightly lower temperature and higher humidity are needed for duck eggs. It is best to follow the manufacturer's directions in operating all incubators. The average operating temperature of still-air incubators varies, because of the different rates of air movement in the various kinds of incubators, from 100½° to 103° F. For best results the temperature should be lowered about ¼° F. at the time of hatching. The average temperature for Indian Runner duck eggs should be about ¼ degree higher than that for White Pekin eggs throughout the incubation period. Forced-draft incubators are operated at a temperature of 99.5° F.

Temperature readings in still-air incubators are made with the bulb of the thermometer 2 inches from the bottom of the egg tray. The temperature should read higher when the bulb of the thermometer is more than 2 inches above the egg tray, and lower if the bulb is at a lower level. The temperature of the incubator room may influence the temperature at which the incubator is operated. A desirable temperature of the egg room is about 60° F. If the room temperature is low, for example 40° F., the incubator temperature should read about ½° F. higher during the period of incubation; if the temperature is high, for example 80° F., the incubator temperature

should read about ½° F. lower. In agitated-air incubators similar corrections may be made, but not to exceed ¼° F. each way.

In the newer makes of incubator, provision is made for supplying the proper amount of moisture. In the older incubators, especially the smaller ones, this is left quite largely to the discretion of the operator.

The relative humidity during the first 24 days should be 65 to 70 per cent; for the last 4 days, from 55 to 60 per cent. This applies to all types of incubators. In forced-draft incubators with separate hatchers, the wet-bulb reading for the first 24 days should be from 89° to 92° F.; and during the last four days in the hatcher, from 85° to 87° F. The wet-bulb measurement of humidity cannot be used satisfactorily in the still-air type of incubators.

In small incubators moisture is usually provided after the first week either by sprinkling the eggs daily with lukewarm water or by placing a pan filled with water or wet sand below the egg tray. Soaking the floor of the incubator room with water also is helpful. The amount of moisture supplied depends on the climate and on the humidity in the incubator room.

The eggs should be turned at least twice daily in small incubators, and three or four times if possible. In agitated-air incubators with automatic turning devices, it will pay to turn them three or four times.

The supply of fresh air should be small to moderate up to the twenty-fourth day; after that large amounts are desirable.

The eggs should be tested on the seventh and twenty-first days.

Care of ducklings. *Brooding.* Young ducks can be brooded with hens or by artificial means. When hens are used, they should be confined and the ducklings given free range, as the hens are likely to tire the ducklings by wandering away too far.

With artificial brooders, any type of equipment which is operated successfully with chickens can be utilized. The duck-

lings are hardened off in the incubator and are removed to the brooder from twenty-four to thirty-six hours after the hatch is completed. Usually from 100 to 150 ducklings are placed in a pen 6 by 12 feet, or in an average-sized colony brooder house. The temperature under the brooder should be about 95° F. for the first week, from 80° to 85° the second week, from 70° to 75° the third week, and thereafter not more than 70° F. The length of time that artificial heat is necessary will depend on the season of the year and on weather conditions. The ducklings are kept close to the hover during the first three or four days until they learn where to go to get warm. The method is similar to that for chickens. The pens may be bedded with 1 or 2 inches of straw or shavings and should be cleaned twice a week at first and once a week later.

On the commercial duck farms the ducklings go directly from the incubator to what is called a "hot house" where the room temperature is kept at about 70° F. After two weeks they are transferred to another house where the temperature is kept lower, and later to a cold house.

When the weather is good in winter, the ducklings are permitted to run out of doors after they are about two weeks old. They may be allowed out of doors sooner in warm weather. Ducklings should have shade in very warm weather and should be amply protected when it is very cold, especially in wet weather. Good ventilation and sanitation are necessary at all times. As a rule they should not be allowed to swim until they are seven or eight weeks old.

Fig. 206 A drinking pan and guard for young ducks.

Feeding. Ducklings are usually fed within thirty-six hours after the hatch is completed, or as soon as they are placed in the brooder house.

Crumbly wet mash is fed four or five times a day during the first week or two. Later the number of feedings is reduced to three or four.

Fig. 207. A metal feeding pan for young ducks.

Fresh drinking water should be provided at each feeding period. The fountains should be so arranged that the ducklings can submerge their bills in the water but cannot get into it to wet their bodies (Fig. 206). This permits them to drink and also allows them to cleanse their nostrils by squirting water through them. Any food left over after the ducklings have had their fill should be removed. Sand or grit should be kept before them at all times.

Chopped fresh green feed or cooked vegetables are often used in the ration for ducklings as well as for older ducks.

No grain is fed to ducks grown for market. The following rations are suggested for growing and fattening ducklings.

Pellets. Commercial pellets are used in place of wet mash by some duck growers for starting and growing ducklings and for breeder ducks. It is claimed that pellets reduce labor and handling costs, prevent waste, are more sanitary, do not attract flies as much as does wet mash, and are more convenient. Growth appears to

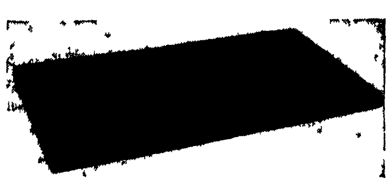


Fig. 208. A feeding tray for older ducks.

TABLE LV

RATIONS FOR DUCKLINGS

Ingredients	Starting Rations for Ducklings from 1 to 6 Weeks of Age			Growing and Fattening Rations for Ducklings from 6 to 12 Weeks of Age		
	1	2	3	1	2	3
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Yellow cornmeal.......	690	700	675	785	800	775
Wheat bran..........	300	300	300	300	300	300
Wheat standard middlings...............	200	200	200	200	200	200
Wheat red dog flour....	300	300	300	300	300	300
Soybean meal.........	150	150	150	150	150	150
Meat scrap (55 per cent protein)*	100	125	150	75	75	100
Dehydrated alfalfa meal (17 per cent protein).	120	120	120	100	100	100
Dried skimmilk	100	...	...	50	...	...
Dried buttermilk......	...	65	...	...	35	...
Dried whey..........	...	...	65	...	...	35
Pulverized limestone...	30	30	30	30	30	30
Salt.................	10	10	10	10	10	10
Vitamin D from fish oil, feeding oil, or activated animal sterols A. O. A. C. units per pound †	200	200	200	200	200	200
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Total protein (calculated)	18.1	18.2	18.1	16.8	16.6	16.8

* Fish meal may be substituted entirely, or in part, for meat scrap.

† Vitamin D may be omitted from the mash when the ducks run outdoors daily

be as good as when wet mash is fed. Pellets usually are made from regular mash mixtures, and may be slightly more expensive than mash because of the processing.

Available figures show that it takes from 25 to 30 pounds of feed to grow a duckling to twelve weeks of age. "Green ducks" are young ducks ten to twelve weeks of age, fattened and ready for market.

Marketing ducks. Ducks are usually sold dressed, although in recent years the demand for live ducks in the New York market has increased greatly.

Ducks are killed by the same method as chickens.

The feathers are removed by scalding or steaming, but dry-picked ducks are preferred in some markets. The water for scalding should be just below the boiling point, usually about 190° F., to prevent discoloring the flesh. The ducks should be scalded and picked just as soon as they are through bleeding. If a large number of ducks are to be dressed, a scalding vat should be provided with some means of keeping the water at a uniform temperature. If only a few ducks are to be dressed at a time, a wash boiler serves the purpose. An ordinary metal pail is too small. In scalding, the bird is usually held by the head and feet and soused into the water long enough for the water and steam to penetrate into the base of the feathers and release them. Scalding is sufficient when breast or body feathers can be removed easily. If the head and feet are kept above the surface of the water while being scalded, the birds will retain the bright yellow color in these parts and make a much better appearance on the market.

The breast and body feathers are picked first, working toward the tail. In doing this, the bird is held on the lap of the picker or on a table. The long tail feathers are usually left in, the wings are picked to the first joint, and the neck half-way to the head. The removal of the down, which is the most difficult part of picking a duck, is accomplished by gently rubbing with the hands; but care must be taken not to remove the skin. Another method is to shave it off with a very sharp knife. A method sometimes used is that of sprinkling the body of the duck with powdered resin and then dipping the duck into hot water. The heat melts the resin on the down which is easily rubbed off clean. Long pin feathers are removed by grasping them between the thumb and a dull knife.

To pick ducks quickly requires considerable experience. On the large duck farms an expert picker will pick seventy-five or more ducks in a day.

As soon as the ducks are picked, they are usually washed

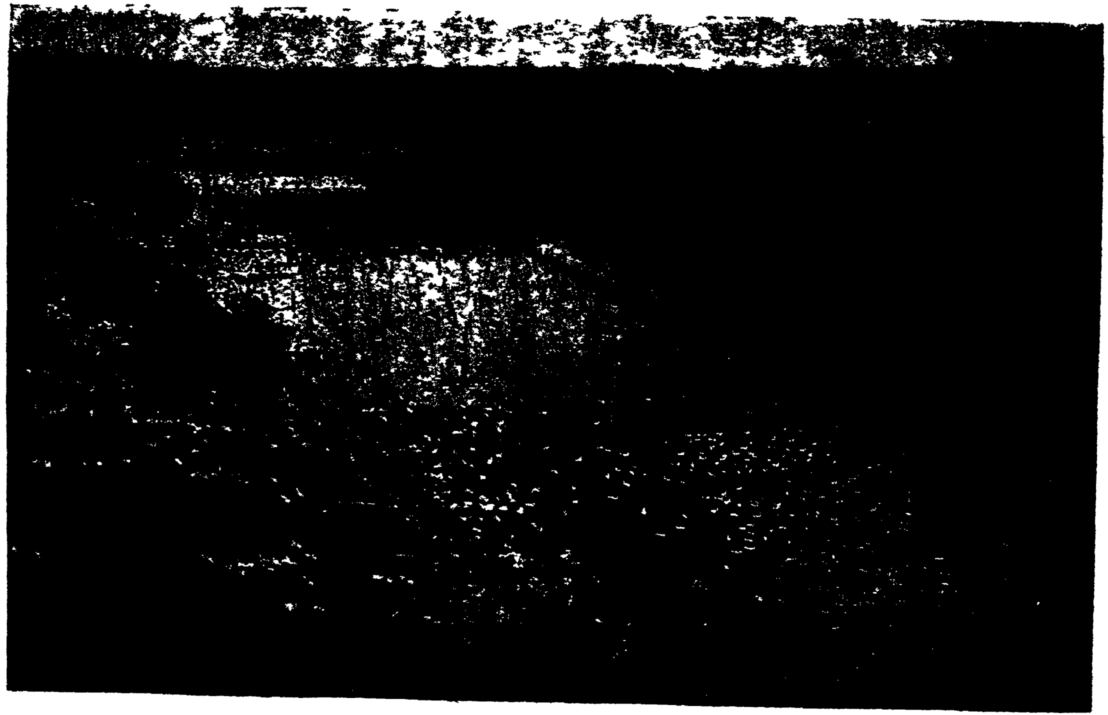


Fig. 209. A large duck farm on Long Island.

and cooled in cold water for an hour or two to remove the animal heat. They are then chilled in ice-water or a cooler and are ready to be packed for market.

In recent years picking machines that work fairly well have been perfected for poultry. One type is in use on some New England duck farms where ducks are dry-picked.

The wax method of picking chickens has been in use for some time, but has not been tried extensively with ducks.

The finer body-feathers are saved and spread thinly in lofts where they are turned frequently and aired until they are dry. They are then sacked and sold to feather dealers. The sale of feathers is an important item on a large duck-farm.

Marketing duck eggs. The market for duck eggs is limited. The best marketing period seems to be in the early spring about Easter time. At that time the price of duck eggs runs several cents higher than that of hen eggs, but during the remainder of the year the average price remains about the same as for hen eggs. The cost of producing duck eggs is probably greater than that of hen eggs; therefore, there is no particular object in keeping ducks to produce market eggs. White eggs are preferred and usually bring the highest price.

Duck troubles due to management. A common cause of the condition known as *staggers* is a temporary shortage of drinking water and the birds feeding before the water supply is replenished, or at the same time. Death usually occurs in such cases in a short time. Cool water from a well, if given to ducklings when overheated, may also be fatal. Such water should stand in the sun until the chill is off before it is placed in the drinking vessels.

Ducklings should never have any food left before them; but a regular supply of drinking water is important.

Ducklings cannot stand the sun after eating; if natural shade is not furnished by trees, some other shelter should be provided.

Feather eating or quill pulling is a habit which frequently

gives trouble in the larger flocks. This is usually remedied by giving the ducks more room or access to water.

During heavy laying, some birds may become ruptured much the same as hens. If cannibalism starts as a result of this, the control is the same as for chickens.

Ducks as a rule are rather vigorous and are less subject to disease than are hens. When disease does occur, it is most likely to be the result of insanitary surroundings and faulty management, or of inherent weakness due to inbreeding.

Diseases of ducks. Ducks raised under the usual commercial conditions are frequently subject to serious mortality. Workers at the Poultry Disease Laboratory of the New York State Veterinary College at Farmingdale, Long Island, report that in most of the cases investigated where heavy losses have occurred, the cause of the trouble was either duck cholera, *Bacterium anatum* infection ("keel"), or faulty incubation, brooding, or feeding. Botulism, tuberculosis, pneumonia or roup, and enteritis are common. Internal parasites except for an occasional tapeworm in old breeders are seldom found. Lice and mites cause trouble in a few instances, but, in general, commercial ducks seem to be free from parasites.

Manure. Duck manure is a valuable source of organic matter for the land. Average analyses show that a ton of duck manure contains about 22 pounds of nitrogen, 29 pounds of phosphoric acid, and 10 pounds of potash. Duck manure, therefore, is about twice as rich in nitrogen, six times as rich in phosphorus, and has as much potash as average farm manure.[2]

GEESE

Geese, like ducks, are raised for meat purposes. They are more easily and profitably grown than ducks, owing to the fact that they subsist very largely on grass and other tender green food during the growing season. For this reason it is

[2] From *Soil and Pasture Management for Long Island,* p. 18–19. By A. F. Gustafson and D. B. Johnstone-Wallace. Cornell Univ. Agr. Exp. Sta. Bul. 755. 1941.

essential to have abundant pasture. Low rough land is sometimes provided but some that is high and well-drained should be available when they wish to get away from the dampness. From 15 to 50 geese are allowed to an acre. The raising of geese in large numbers is somewhat limited by the market. In sections of the Middle West where geese are fattened commercially, or near some of the eastern cities that have a large foreign population, there is a fairly good market.

Fig. 210. Pair of wild geese. (Cornell University.)

Geese are very hardy and, for this reason, can be housed very cheaply as they need protection only during very cold or stormy weather. In the warmer parts of the country no shelter is necessary. They require very little care throughout the year.

When many geese use the same pasture with cattle they will contaminate the land to such an extent that the cattle will refuse to eat the grass. Even with a few geese, it is better to give them a separate pasture. They should not be turned in a young orchard for they are likely to injure the bark of the trees. Shade is desirable in warm weather as geese suffer from the heat.

Breeds of geese. There are six breeds of geese, namely: Toulouse, Embden, Chinese, African, Wild or Canadian, and Egyptian. The Toulouse, Embden, African and Chinese are commonly seen in the United States. The Toulouse and Embden lead the others in popularity.

The Toulouse goose comes from France and derives its name from the city of Toulouse near which it originated. The

color of the plumage is dark gray on the back, gradually shading to light gray on the breast and white on the abdomen. The beak, shanks and toes are deep reddish-orange. (Fig. 211.)

Toulouse geese are the largest of the six breeds mentioned.

Fig. 211 A Toulouse goose. (*U S. Dept. Agr*)

The adult gander weighs 26 pounds; the goose, 20 pounds. They are good layers, producing from twenty to thirty-five eggs a year, but poor setters. They are docile, grow rapidly and are well suited for market purposes.

Embden geese (Fig. 212) come from Germany. They are a large white breed, a little smaller than the Toulouse. Embden geese are not as good layers as the Toulouse but better

setters. Due to their white plumage, this breed makes a better appearance on the market when dressed than the Toulouse.

The other breeds mentioned may be grown for commercial

Fig. 212. An Embden gander. (U. S. Dept. Agr.)

purposes but are usually kept only for exhibition. With the exception of the African goose, they are much smaller.

Selection and management of the breeding stock. Vigor, size

and prolificacy are just as important when selecting geese for breeding purposes, as with other kinds of poultry. Geese should be mated early in the fall previous to the breeding season for best results. A gander may be mated with one to four geese, but usually selects a single mate for life. If the single mating is satisfactory, no attempt should be made to change it. If such matings are changed it is usually necessary to keep the goose and gander far enough apart so that they cannot hear each other. When mated, geese are allowed to run in flocks but during the breeding season it may be necessary to keep each mating by itself, if the ganders fight.

"Sex is difficult to distinguish in geese, especially when they are growing. The gander is usually somewhat larger and coarser than the goose and has a shrill cry, while the female has a harsh, coarse cry. The gander has a longer neck and a larger head. The sex may be determined by inspecting the sexual organs or by the actions of the geese at mating time. The sphincter muscle which closes the anus of the female appears folded if stretched, while a light pressure on the corresponding section of the male will make the sexual organ protrude. This test is more easily made on a mature male and in warm weather. In common geese the male is lighter in color than the female.

"Toulouse and Embden geese will breed and produce some stock in their second year, but do not mature or give best results for another year. They will sometimes lay the first year, but the results are usually unsatisfactory. The females are usually kept until they are from eight to ten years old, or as long as they lay well, but ganders are seldom kept after they are six to seven years old." [8]

During the winter, when growing green food is not available, a limited amount of grain and some green food should be provided for the breeders. A grain mixture composed largely of heavy oats with some corn, wheat and barley can be used.

[8] Lee, U. S. Dept. Agr., Farmers' Bull. 767.

This should be supplemented with large amounts of chopped vegetables, clover or alfalfa hay or silage. The birds should not be allowed to become too fat as this affects the fertility of the eggs at hatching time.

As the breeding season approaches, a wet mash may be fed in addition to the other food. The following is suggested:

3 parts of wheat bran or shorts
1 part of yellow corn-meal
¼ part of meat scraps or powdered buttermilk

or

The duck breeder mashes on page 538 or the chicken breeder mashes on page 217.

Water, oyster-shells and grit should always be accessible.

Hatching goose eggs. It is not advisable to hatch the goslings until the grass is green. Goose eggs are set either under hens or geese. Incubators have not been used extensively for the purpose. Artificial incubation can be used if adjustments for temperature are made as described on page 568, Chapter XXIII. Geese will cover nine or ten eggs and a hen four to six, depending on the season of the year. Eggs set under a hen should be turned, as they are too large for the hen to do this easily. The average period of incubation is thirty days.

When hens are used, the nests should be watched at hatching time and the first goslings, as soon as they hatch, should be removed to a flannel-lined basket and kept in a warm place until the youngest goslings are several hours old. Unless this is done, the hen is likely to leave the nest with the older goslings before the late ones are sufficiently strong.

During the first three or four days after hatching, it is very important to keep the goslings dry. It is best at this time to confine the hen and let the goslings run when the weather is fine. The goslings should always be confined when it rains or while the dew is on the grass. They should not be allowed to swim until they are two to four weeks old, or until they are

fully feathered on their breasts. Even after that they should be protected on rainy days until they are well coated with feathers. If once they become thoroughly drenched with water and chilled before their feathers are grown, they are likely to die from exposure.

Feeding goslings. Goslings should not be fed until they are at least thirty-six hours old. The first food should consist of stale bread, soaked in milk or water and then squeezed dry, to which finely chopped eggs and green food is added. This should be fed three or four times a day. Plenty of water in protected fountains and sand or grit should be provided. After two or three weeks, in addition to the green food secured on a good range, it is advisable to give a light feeding of wet mash composed of two parts of middlings and one part of corn-meal. At six weeks of age, if necessary, a mash composed of equal parts of corn-meal, middlings, and ground oats with 5 per cent of meat scrap may be given. It is possible to grow goslings from two to three weeks of age to maturity successfully with very little extra feed except what they get on a good range. The feeding of some grain, however, is better.

Preparing geese for market. Geese are easily fattened in the late autumn and early winter. Corn, in the most convenient form, should be fed abundantly. This should be supplemented with chopped vegetables, grit and water. A wet mash composed of corn-meal and middlings can also be used. Geese are sometimes fattened by a method called "noodling." Each bird is caught and given several pellets of food by hand. Although this produces a nicely fattened goose, it requires considerable labor.

Geese are killed, picked and shipped in much the same manner as ducks.

Plucking live geese. The plucking of feathers from live geese has been practiced for centuries. About 1 pound of feathers may be plucked from a goose during a year. The feathers should never be plucked during the winter or breeding season.

SWANS

Swans, like peafowl, are kept largely for ornamental purposes. Their beauty and gracefulness in the water has led to the saying "graceful as a swan."

Swans are very hardy and need little protection except in the coldest stormiest weather. The adult swan ranges in weight from 20 to 30 pounds. They are not bred extensively in the United States, but in England and other countries there are large swanneries.

Swans pair and remain faithful to each other until death. At any time the male is inclined to be hostile toward other birds and man, but during the period of incubation and afterward he is particularly pugnacious, attacking man or beast whenever they approach the nest or the young.

At breeding time a large nest is made of sticks and rubbish, in which from six to eight large greenish-white eggs are laid. The nest is located on the bank of a river or pond, close to the water. The period of incubation is about six weeks. Although the parents give the cygnets the finest care, they are very susceptible to cold weather and many die from exposure, especially if the season is unfavorable.

The adult swan usually lives on water plants, soft roots, and aquatic insects. In winter it is necessary to feed other food, particularly green food. Old birds may be fed the same as ducks. They will eat stale bread or prepared game foods readily.

Swans live to be very old. The female will breed for thirty years and the males have been known to live for more than sixty years.

XXII. Pigeons

PIGEONS are kept extensively in all parts of the United States for squab production, flying and exhibition. During the World War they were very useful in carrying messages when telephone and radio communications were interrupted. In peace times their care and breeding furnishes profit, pleasure and recreation to young and old alike. In recent years the demand for squabs in such markets as New York City has led many breeders to take up this phase of pigeon-keeping more extensively. The discussion in this chapter will have to do largely with squab production (Fig. 213).

BREEDS OF PIGEONS

Of the many varieties of domestic pigeons the best all-around one for squab-raising is probably the American Antwerps or Homers. They are prolific, hardy, active, quiet in temperament and good feeders and mothers.

Carnean pigeons, red and yellow, are used by some breeders because of the large squabs they produce. They are very hardy but less prolific than the Homer.

The White King and White Swiss Mondaine are similar to the Carnean in general type.

The Runt is the largest variety of pigeons raised for squabs but because of its size, it is inactive, unprolific and a poor worker, seldom producing more than four pairs of squabs in a year. The choice of a breed is quite important. It is also advisable to choose a variety with several years of careful breeding behind it. The results with common stock are usually disappointing.

HOUSING SQUAB-PRODUCING PIGEONS (Figs. 214–215)

The requirements for a house for pigeons are essentially the same as for poultry. It should be well ventilated, dry, well

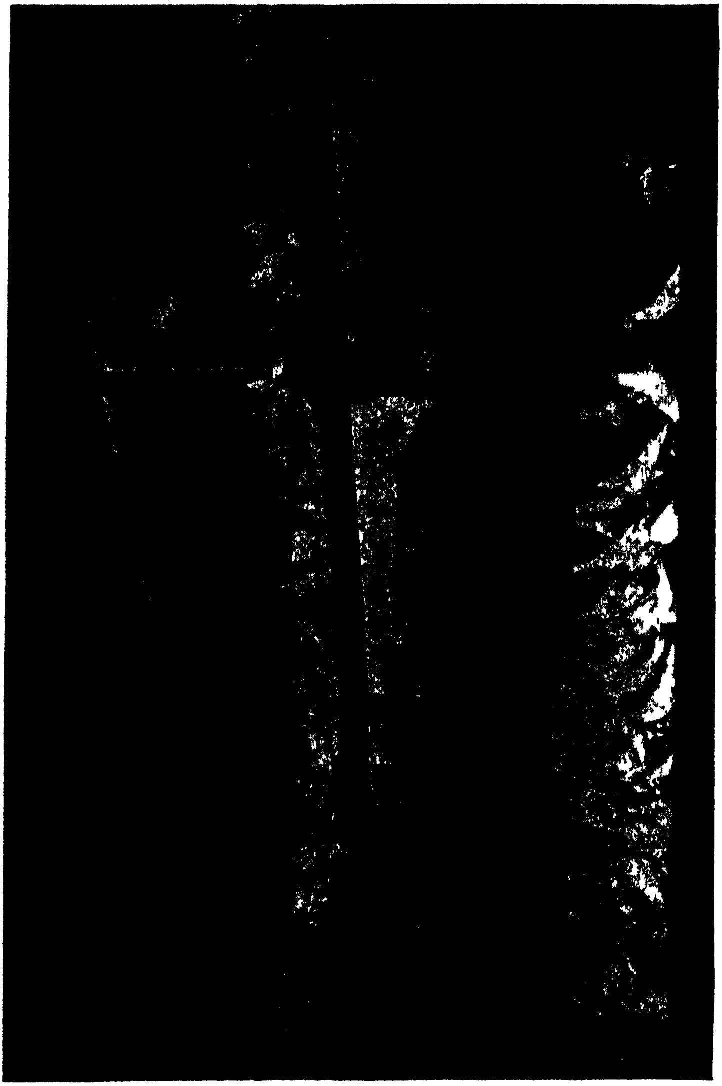


Fig. 213. Good type of pigeon for squab production. (Cyclopedia of Am. Agr.)

lighted and roomy enough to permit the attendant to work conveniently. A specially constructed house is unnecessary. Many paying lofts have been made by fixing over an unused wagon house or barn scaffold.

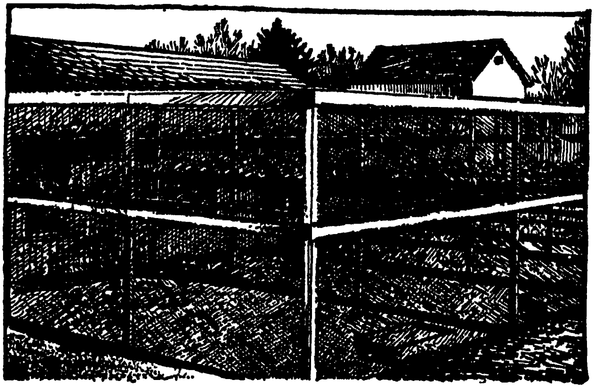


Fig. 214. Shed-roof pigeon house with fly.

The construction of the floor is important, for whatever material is used it should be dry at all times, rat-proof, easily cleaned and disinfected, comfortable and warm. Cement makes a very sanitary floor and if properly constructed will be dry. Long houses should run north and south with the flies on either side. Such a house should be wide enough for an alley through the center with rooms on either side. The flies should be as wide as the pen, 25 feet long and 8 or 10 feet high.

In a pigeon loft the nests are another very important part of the equipment. Two separate nests should be provided for each pair of breeders, and many raisers supply a few additional ones. This is because each pair of birds frequently sit on eggs in one nest while rearing a pair of squabs in another. The nests vary in size but usually they are built about 12 inches wide, 12 inches long and 8 to 12 inches high. They are usually constructed in batteries of any convenient number arranged in tiers one above the other along the side walls. "The

ideal nest is made with a loose bottom slid in on cleats. In cleaning, these bottoms are pulled out like a drawer, cleaned with one stroke of a trowel and replaced. They are made with boards 12 inches wide. On each side of these boards cleats are nailed 12 inches apart, and the boards are placed on end and fastened to the side of the house 12 inches apart, extending from the floor to the ceiling (Fig. 215). When in position, boards cut twelve inches wide with strips three inches high nailed on one side are placed on these cleats and form the bottom of the nest, the three-inch cleat forming the front to keep the nest in place and the young from falling out."[1] To hold the nest material in place a wooden, metal or earthenware bowl about 3 inches deep and 10 inches in diameter is generally used. Equal amounts of straw and tobacco-stems are provided for nest material. The tobacco-stems prevent vermin.

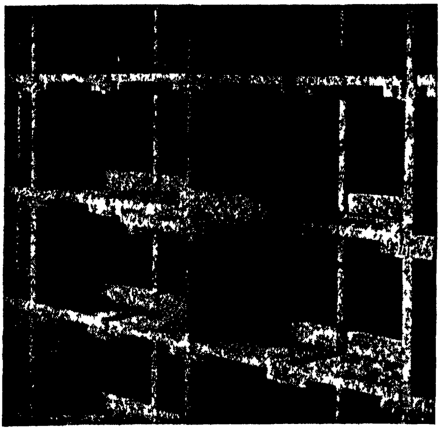


Fig. 215. Nests in a pigeon house.

A roosting place should be provided for each pair of birds on the side walls of the pen.

Bathpans about 2 feet in diameter and 4 inches deep should be provided. These are usually placed in the fly.

An inch of sand makes a good covering for the floor.

FEEDING PIGEONS

Pigeons live largely on grain. Almost any kind may be used

[1] Gillingham, Geo. L., "Squab Raising," The Poultry Raising in N. Y. State. Bull. 134.

but it must be of the finest quality. No mash is fed. The following ration has been satisfactory:[2]

33 lbs. cracked corn	5 lbs. rice
25 lbs. red wheat	1 lb. hemp seed
25 lbs. kafir corn	1 lb. millet
10 lbs. split peas	

The birds are fed morning and night in trough-feeders as much grain as they will consume in about an hour's time. Oyster-shell, charcoal, grit and salt are supplied in small hoppers. Twenty-five pairs of pigeons will eat about 4 pounds of grain daily. Regular and abundant feeding is necessary if nice plump squabs are desired.

MATING PIGEONS

Pigeons, as a rule, are monogamous and will remain constant to each other for life. It is this fact which makes it possible to keep so many pairs in a pen and have them work successfully. Occasionally, however, a bird will be untrue and cause trouble in the pen or one of a pair will die; in such cases the unmated birds should be removed.

While pigeons begin to mate at six or seven months and are doing fairly good work at one year, the production of squabs is the highest at two and a half to six years. In the prime of life when well-bred and mated, pigeons often produce from five to eight pairs of squabs during a year.

In selecting young birds to replace the flock, it is best to choose from nests containing two squabs of nearly equal size and age from the same mating. Both squabs should be taken for if the largest one is always chosen a larger percentage of males is likely to result. By following a careful system of selection for size, shape, and vigor, the type of the squabs can be improved greatly. As fast as the squabs are selected for

[2] From a paper on Squab Production by H. E. Botsford, Poultry Dept., Cornell Univ.

breeding purposes they should be banded for identification. They should then be placed in a pen with similar birds to complete their growth. As soon as mating begins and nests with eggs are discovered, the sex of each pair should be determined. This is usually done by watching to see which bird sits during certain hours of the day. The male usually sits on the nest from early morning to late afternoon and the female during the remainder of the time. The male may then be banded with a certain colored band on the right leg and the female with the same color of band on the left leg. The male can also be distinguished by his aggressive actions, coarser appearance and larger size.

The female pigeon usually lays two eggs, skipping a day between eggs and then is ready to set. The period of incubation is seventeen days. If both eggs hatch and prove to be a pair, the male will hatch first.

During incubation a substance forms in the crops of both birds known as "pigeon milk" or curd, on which the young are fed for the first five or six days, or until they are old enough to digest grain. At first the grain is carried to them in the crop of the old birds and discharged from it to the mouth of the young bird by the same process as the pigeon milk is fed. As the parents usually feed the young shortly after feeding themselves, the young birds are very quickly affected, if the feed is musty, sour or spoiled.

As a rule from three and a half to four weeks are required to grow a good squab. They are ready to be killed when the body-feathers under the wings are just past the pin-feather stage. They are not as desirable for market purposes if left a few days longer or until they leave the nest.

MARKETING SQUABS

Squabs should be killed when their crops are empty. To do this, it is advisable to catch them either the night before, after the old birds have fed them, or in the early morning be-

fore feeding time. They can then be kept in baskets until they are killed. Before being bled the feet are tied, or better still slipped into a wire which is bent to hold their legs apart. The blood is caught and the bird held in place, by a blood-can hooked on the inside of the bill. This method of holding the birds facilitates the picking. A free flow of blood is highly desirable.

After the squab is picked, it is cooled and then packed between layers of cracked ice in boxes or barrels for shipment.

Commission houses sell squabs by the dozen, the weight and evenness of a dozen determining the grade. White-skinned squabs sell better than those with a dark skin.

VERMIN AND SANITATION

Pigeons are remarkably free from disease when proper sanitary measures are followed closely.

Every means should be taken to keep rats and mice out of the loft for they often frighten and annoy the parent birds until they neglect their young. This often results in high mortality among the squabs. Well-constructed cement floors and tight walls will help to prevent vermin from entering freely.

XXIII. Pheasants

PHEASANT-RAISING in the United States dates back to 1880 when pure ringneck pheasants from China were introduced into the state of Oregon. A few years later, ringneck pheasants of a little different breeding but similar appearance were brought to New Jersey from England. After considerable expense and much patience this type of pheasant finally became established in the eastern and western parts of the country. Other varieties have been tried but the ringneck pheasant (Fig. 216) seems to be more hardy and better adapted to American climatic conditions than the others. It has now become so thoroughly naturalized in so many states in the northern part of the United States that it is fast becoming America's leading game bird.

According to Quarles: "Pheasants other than common ringnecks which are more or less commonly bred by the large commercial breeders are Chinese, Mongolian, Japanese (versi color), Prince of Wales, Reeves, Golden (Fig. 217), Silver and Amherst. The four first mentioned belong to the genus Phasianus, whose members are known as true pheasants, and are all more or less of the type of bird adapted to the coverts

Fig. 216. Male ringnecked pheasants. (Cornell University.)

of this country. The remaining species of the list are commonly referred to as aviary birds and, generally speaking, are not adapted to such cover as is typical of the United States.

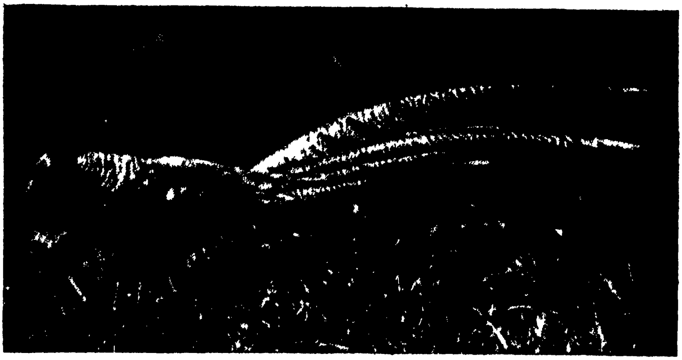


Fig. 217. Male Golden pheasant. (Cornell University.)

For that reason, these are seldom liberated but drag out what must be a rather miserable existence in an aviary."

BREEDING AND CARE (Figs. 218, 219)

Pheasants breed early in the spring, soon after the snow disappears, consequently they should be put into breeding quarters about a month before laying starts.

In breeding pheasants two systems are followed: One consists of keeping a large number of birds together, usually not more than 100, in a large inclosure; the other method is to keep each breeding unit of a cock and five hens in a small separate pen by themselves. When the former method is used, the pen is open on top but the small pens are covered. Two-inch-mesh chicken wire is employed in all cases except at the bottom of the fences where one-inch-mesh is used to keep out vermin. The fences surrounding the large inclosures are usually made about 8 feet high with an overhanging strip of wire around the top, 2 feet wide, to prevent birds or animals climbing in or out. The fence extends about a foot into the ground

to prevent animals from digging under. The best type of small pen is 12 x 14 x 6 feet and movable. To prevent the birds from flying out of the large inclosures or injuring themselves by

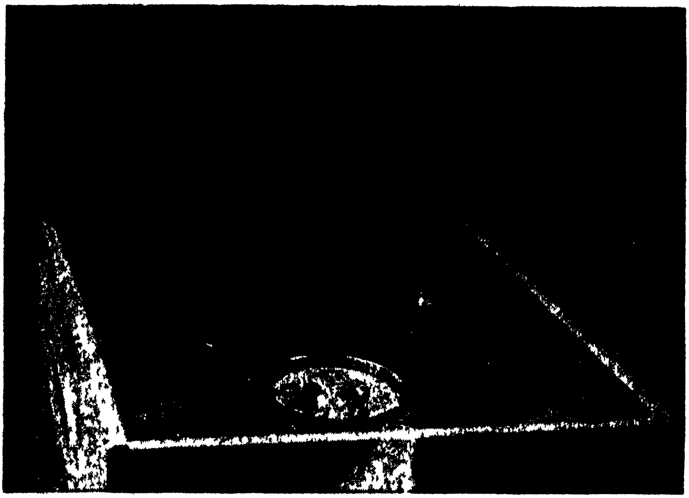


Fig. 218. Hen with young pheasants. A temporary inclosure should confine the chicks for the first three or four days. (Cornell University.)

flying against the fences, the main quills in one wing are clipped. Pinioning is sometimes practiced but is not generally approved.

In both the large and small pens, hiding places of brush or trees should be provided.

The best location for the pens is on well-drained, easily tilled, fertile land sloping gently toward the south. For convenience and safety the pens should be as near the residence as possible. The field in use should be in sod.

Pheasants require little protection except in extremely cold or stormy weather in winter when a shed open on one side should be provided. The cocks are usually kept separate from the hens.

The feed consists of scratch grain and mash such as is fed

to poultry. During the breeding season a special breeding ration is fed, such as is recommended for turkeys and chickens.

Fig. 219. A double-section breeding pen. Note hiding places in the corners (Cornell University.)

HATCHING AND REARING PHEASANTS

Pheasant eggs are usually incubated under common hens, as pheasant hens in captivity are practically non-sitters.

Artificial incubation and brooding are relatively new in the propagation of game birds. Both are used successfully and are desirable for large scale production.

NATURAL INCUBATION AND REARING

When natural methods are employed, from nineteen to twenty-one eggs are placed under one hen. It takes about twenty-four days for the eggs to hatch. The selection and care of a setting hen has already been discussed in Chapter VII, page 123.

While the chicks are hatching and drying off, which takes from twenty-four to thirty-six hours, the hen and young are left entirely alone.

About seventeen or eighteen chicks are allowed to each hen. The field is usually fenced and seeded to grass, clover, or al-

falfa through which strips have been mowed. These strips are about six feet wide and about 45 feet apart. The coops are set in these paths about 45 feet apart. The field should have shade and sunshine, abundant insect life, and well-drained soil. A field with a few large trees here and there about it often fills these requirements very well. After a field is once used it should not be used again for three years.

During the first four or five days the hen is confined to the coop, but the young pheasants have the range of a small wire-covered yard 3 feet long and 2 feet wide. The coop and pen should be examined carefully to see that it contains no small holes through which the chicks can escape and become lost. At the end of this period, when the chicks have learned the call of the hen and the location of their home, they are ready to be given a wider range, if the weather is good. Some care-takers keep the hen confined, others keep her confined for a week or longer after this and then allow her to range with her brood. The coop is moved daily while the hen is confined, but when the hen has free range it may be moved every third day. One must not confine the young pheasants after the fourth or fifth day.

After the young pheasants are two weeks old, they are well able to withstand ordinary wet weather and early morning dew provided they have their dry coop as a shelter. The growing birds are very hardy, grow rapidly, and are well able to take care of themselves at the end of six or seven weeks when they are fully feathered.

FEEDING YOUNG PHEASANTS

The young pheasants should not be fed until about eighteen hours after they are removed from the nest, and they should never be given more feed than they will eat up clean. If a little of the chick food is placed where the hen can reach it, she will teach the chicks to come to her call. The hen should be supplied with whole corn regularly while in captivity.

The following methods and rations are recommended by the New York State Conservation Department: "The first week the little birds should be fed three or four times each day. The food should consist of hard boiled eggs, chopped fine and mixed with an equal amount of slightly moistened stale bread or cracker, so as to form a dry, crumbly mash. Boiled eggs are inexpensive food and are easily prepared. Two boiled eggs are sufficient to provide three meals for fifteen or twenty pheasant chicks.

"During the second week, commercial chick-grain, rolled oats or crushed wheat are added to the ration. Chick-grain is a staple article and may be bought at any feed store. Three meals a day should be given as follows: Morning meal—Chopped boiled egg mixed with an equal amount of slightly moistened bread or cracker to the consistency of a dry, crumbly mash. Noon meal—Chick-grain or crushed wheat moistened with water. Evening meal—Hard boiled egg mixed with moistened bread or cracker, and one or two handfuls of dry chick-grain, rolled oats, crushed wheat, chick starting mash, or any small grains. The young birds are very fond of curd (cottage cheese), and scraps from the table occasionally furnish a good relish.

"When the young pheasants are two weeks old, their meals may be reduced to two a day. After this time the ration should be chick-grain, rolled oats or crushed wheat moistened with water, and an occasional feed of the chopped boiled egg mixed with moistened bread or cracker.

Instead of the above procedure most caretakers feed a turkey or chicken starter mash moistened.

"From the fourth week until maturity, almost any dry grains may be given—cracked corn, wheat, buckwheat, 'scratch feed,' etc.—such as farmers ordinarily use for the feeding of chickens." The grain mixtures given in Table XLIX, page 514, and mash formulas in Table L, page 521, are suitable for pheasants.

ARTIFICIAL INCUBATION

Pheasant eggs can be hatched in either the still-air or agitated-air incubator. The same general principles with some important variations govern the artificial hatching of both pheasant and hen eggs. The operating temperature of still-air incubators varies from 101½ to 103½° F., depending upon the make of the incubator and the position of the thermometer. Romanoff[1] suggests the following procedure in determining the correct temperature in a still-air incubator: "Before setting the eggs the temperature reading should be checked in the egg tray on the level of the top and bottom of the egg. In doing so one should place one clinical thermometer on the floor of the tray and another on the level of the top of the egg, and subtract the difference in temperature readings. The optimum temperature for the incubation of the eggs is 99.5° F. at a point ½ to ⅔ of the distance from the bottom to the top of the egg. It is a good policy to check the incubating temperature at *the beginning of each hatch throughout the* season. Because as the season advances the temperature of the incubator room may increase. With an increase or decrease in room temperature from 60° F. it is necessary to decrease or increase the temperature in the incubator in order to maintain the optimum temperature of 99.5° F."

According to Romanoff: "At a constant humidity and air movement, pheasant eggs require higher temperature at the beginning and lower temperature at the end of incubation, perhaps as much as 1° F. difference." A higher humidity is also best at the beginning and a lower one at the end of incubation. A reduction from about 70 per cent relative humidity to 60 per cent is suggested.

The proper temperature in an agitated-air incubator is 99½° F. Romanoff recommends that eggs that have been

[1] Bul. 2, N. Y. State Cons. Dept., Albany, N. Y.

incubated for the first twenty days in this type of incubator may thereafter be hatched most successfully in a still-air type incubator with a slightly lower temperature (about one-half degree F.) and lowered relative humidity (about 3–5%) from the average conditions recommended for the type of incubator. In the incubator without separate hatcher the temperature should be about 99½° F., throughout, with wet bulb reading about 87–89° F. (about 63% relative humidity) and with a continuous moderate supply of fresh air.

ARTIFICIAL BROODING

Artificial brooding of pheasants reduces the chance of introducing disease from the hens and economizes on labor. The houses, equipment, yards, and method of caring for the birds are similar to those used for poultry. It is customary to provide a temporary yard about 100 x 50 feet on one side of a movable brooder house the first year and on the opposite side the second year. The third year, the brooder house should be moved to a new location.

The fences enclosing this yard should be eight feet high, with ¾-inch-mesh poultry fencing twenty-four inches high at the base and 1½-inch-mesh poultry fencing seventy-two inches high at the top. The bottom of the wire should be fastened carefully to the ground with wooden pegs so that the chicks will not escape.

Care must be taken not to overcrowd the brooding facilities. Each chick should be allowed ten to twelve square inches of hover space, sixty to seventy square inches of pen space, and about one to one and one-half linear inches of feeding space. The outside yard should be large enough to allow at least six or seven square feet per chick.

The chicks can be allowed to run out in the yards after the second or third week; they should be driven into the house at night until they are five weeks old. At six weeks of age they

can be shut out-of-doors so that they will become accustomed to nature before liberation. Brush piles in the corners of the yards act as shelters.

FEEDING

Artificially brooded pheasants are given dry mash and grit from the start. They do not receive any wet mash such as that given to hen-reared birds. Due to the rapid growth of pheasants, it is advisable to use a mash containing a higher protein content than is used for rearing chickens. Most any of the turkey or game bird mashes with a protein content of twenty-four per cent give satisfactory results. These mashes may be fed in pellet form. A pelleted mash reduces waste and eliminates the dust which is detrimental to small birds.

The chicks are fed chick scratch grain when they are two weeks old, and at about four weeks they are given intermediate scratch grain.

Appendix

TABLE 1

Classification of Breeds and Varieties of Poultry According to the American Standard of Perfection

Class	Breed	Variety
1. American	Plymouth Rocks	Barred White Buff Silver-penciled Partridge Columbian Blue
	Wyandotte	Silver-laced Golden-laced White Buff Black Partridge Silver-penciled Columbian
	Wyandotte Bantams	White Black Buff Partridge Silver-penciled Columbian
	Javas	Black Mottled
	Dominiques	
	Rhode Island Reds	Single-comb Rose-comb
	Rhode Island Whites	
	Buckeyes	
	Chanticleer	
	Jersey Black Giants	
	Lamonas	
	New Hampshires	
2. Asiatic	Brahmas	Buff Light Dark
	Cochins	Buff Partridge White Black
	Langshans	Black White
	Brahma Bantams	Dark Light
	Cochin Bantams	Buff Partridge White Black

TABLE 1—(*Continued*)

Class	Breed	Variety
3. Mediterranean	Leghorns	Single-comb dark brown Single-comb light brown Single-comb white Single-comb buff Single-comb black Single-comb silver Single-comb red Single-comb black-tailed red Single-comb Columbian Rose-comb dark brown Rose-comb light brown Rose-comb white
	Minorcas	Single-comb black Rose-comb black Single-comb white Rose-comb white Single-comb buff
	Spanish	White-faced black
	Blue Andalusians	
	Anconas	Single-comb Rose-comb
	Buttercup	
4. English	Dorkings	White Silver-gray Colored
	Redcaps	
	Orpingtons	Single-comb buff Single-comb black Single-comb white Single-comb blue
	Cornish	Dark White White-laced red
	Sussex	Speckled Red Light
	Australorps	
5. Polish & Polish Bantams	Polish Similar varieties are produced in the Polish Bantams	White-crested black Bearded golden Bearded silver Bearded white Buff-laced Non-bearded golden Non-bearded silver Non-bearded white None-bearded buff-laced
6. Hamburgs	Hamburgs	Golden-spangled Silver-spangled Golden-penciled Silver-penciled White Black

TABLE 1—(*Continued*)

Class	Breed	Variety
7. French	Houdans	Mottled
		White
	Crevecoeurs	Black
	LaFlèche	Black
	Faverolles	Salmon
8. Continental	Campines	Silver
		Golden
9. Games and Game Bantams	Games	Modern black-breasted red
		Modern brown-red
		Modern golden duckwing
		Modern silver duckwing
		Modern birchen
		Modern red pyle
		Modern white
		Modern black
		Old English black
		Old English spangled
		Old English white
		Old English red pyle
		Old English silver duckwing
		Old English golden duckwing
		Old English brown-red
		Old English black-breasted red
	Game Bantams	Remaining varieties same as for Games
10. Orientals	Sumatras	Black
	Malays	Black-breasted red
	Malay Bantam	Black-breasted red
11. Ornamental Bantams Feather Legged	Mille-Fleur	Bearded
	Silkies	Non-bearded
	Booted	White
Clean Legged	Sebrights	Golden
		Silver
	Rose-comb	White
		Black
	Japanese	Black Tail
		White
		Black
		Gray
12. Miscellaneous	Sultans	White
	Frizzles	Any color

TABLE 2

STANDARD WEIGHTS OF FOWLS REQUIRED BY THE AMERICAN STANDARD OF PERFECTION

CLASS	BREED	COCKS POUNDS	HENS POUNDS	COCKERELS POUNDS	PULLETS POUNDS
1. American	Plymouth Rocks	9½	7½	8	6
	Wyandottes	8½	6½	7½	5½
	Javas	9½	7½	8	6½
	Dominiques	7	5	6	4
	Rhode Island Reds	8½	6½	7½	5½
	Rhode Island Whites	8½	6½	7½	5½
	Buckeyes	9	6½	8	5½
	Chanticleer	8½	6½	7½	5½
	Jersey Black Giants	13	10	11	8
	Lamonas	8	6½	7	5½
	New Hampshires	8½	6½	7½	5½
2. Asiatic	Brahmas, Dark, Buff	11	8½	9	7
	Brahmas, Light	12	9½	10	8
	Cochins	11	8½	9	7
	Langshans	9½	7½	8	6½
3. Mediterranean	Leghorns	6	4½	5	4
	Minorcas	8 *	6½	6½	5½
		9 †	7½	7½	6½
	Spanish	8	6½	6½	5½
	Blue Andalusians	7	5½	6	4½
	Anconas	6	4½	5	4
	Buttercups	6½	5	5½	4
4. English	Dorkings, white	7½	6	6½	5
	silver-gray and colored	9	7	8	6
	Redcaps	7½	6	6	5
	Orpingtons	10	8	8½	7
	Cornish, dark and white	10½	8½	8½	6½
	white-laced red	8	6	7	5
	Sussex	9	7	7½	6
	Australorps	8½	6½	7½	5½
5. Polish	Polish	No weights. About like Leghorns.			
6. Hamburgs	Hamburgs	No weights given. A little smaller than Leghorns.			
7. French	Houdans	7½	6½	6½	5½
	Crevecoeurs	8	7	7	6
	LaFlèches	8½	7½	7½	6½
	Faverolles	8	6½	7	5½
8. Continental	Campines	6	4	5	3½
9. Orientals	Sumatras	No weights given.			
	Malays	9	7	7	5
10. Ornamental Bantams ‡					
11. Games and Game Bantams		No weights given.			
12. Miscellaneous		No weights given.			

* Single-comb and Rose-comb white, Rose-comb black, and Single-comb buff.
† Single-comb black.
‡ See the American Standard of Perfection for weights

TABLE 3

THERMAL-INSULATION, OR HEAT-RESISTANCE, VALUES, AND THERMAL CONDUCTIVITY OF VARIOUS MATERIALS [1]

Material	Thermal Insulation, or Heat Resistance of Materials		Thermal * Conductivity of Materials
	Thickness 1 inch A	Thickness as manufactured B	C
Air space:			
Air space, tightly sealed	...	0.91	1.10
Air space, faced with bright aluminum foil.			
$\frac{3}{8}$ inch wide faced on one side	...	1.61	0.62
Over $\frac{3}{4}$ inch wide faced on one side	...	2.17	0.46
$\frac{3}{8}$ inch wide faced on both sides	...	1.75	0.57
Over $\frac{3}{4}$ inch wide faced on both sides	...	2.44	0.41
Insulating blanket:			
Balsam Wool	3.85	...	0.26
Dry Zero	4.15	...	0.24
Hair Felt	3.85	...	0.26
Manufactured rigid board:			
Cement and asbestos sheets	0.37	...	2.70
Insulating board, $\frac{7}{16}$ inch thick, Celotex, Insulite, Thermosote, Masonite, Tentest, Maftex, Temlok, or similar insulating board (average)	...	1.32	0.76
Insulating board, as above, 1 inch thick	3.02	...	0.33
Insulating board, as above, $\frac{25}{32}$ inch thick	...	2.36	0.43
Plaster Board, Sheet Rock, Gypsum Board, $\frac{3}{8}$ inch thick	...	0.27	3.73
Masonry:			
Stone masonry	0.10	...	10.00
Brickwork	0.25	...	4.00
Concrete (stone)	0.125	...	8.02
Concrete (cinder)	0.19	...	5.20
8-inch concrete block (hollow)	...	1.19	0.84
8-inch cinder block (hollow)	...	2.22	0.45
12-inch cinder block (hollow)	..	3.58	0.28
6-inch load-bearing clay tile	...	1.85	0.54
12-inch load-bearing clay tile	...	3.03	0.33
Hollow-glass wall tile (6 by 6 by 2 inches)	...	1.85	0.54
Wood lath and plaster (ordinary, dry)	...	0.50	2.00
Metal lath and $\frac{3}{8}$-inch plaster	...	0.11	8.80
$\frac{3}{8}$-inch stucco	...	0.11	8.80
Wallfilling materials:			
Asbestos	3.41	...	0.29
Buckwheat hulls	2.78	...	0.36
Cinders, soft coal, screened and fine material discarded	0.80	...	1.25
Cornstalks, milled	2.86	...	0.35
Cotton-seed hulls	2.44	...	0.41
Corkboard	3.33	...	0.30
Regranulated cork ($\frac{3}{16}$-inch particles)	3.33	...	0.30

[1] From Cornell Extension Bul. 451.

TABLE 3 (*Continued*)

MATERIAL	THERMAL INSULATION, OR HEAT RESISTANCE OF MATERIALS		THERMAL* CONDUCTIVITY OF MATERIALS
	Thickness 1 inch A	Thickness as manufactured B	C
Excelsior	2.70	...	0.37
Glass wool	3.70	...	0.27
Hair felt	3.85	...	0.26
Insulex or Pyrocell (27 pounds per cubic foot)	1.16	...	0.86
Insulex or Pyrocell (15 pounds per cubic foot)	2.00	...	0.50
Mineral wool	3.70	...	0.27
Moss, sphagnum	3.70	...	0.27
Rock Cork	2.70	...	0.37
Rock wool	3.57	...	0.28
Shavings (ordinary, dry)	2.44	...	0.41
Sawdust (ordinary, dry)	2.44	...	0.41
Straw	2.56	...	0.39
Straw, cut	2.94	...	0.34
Paper:			
Paper, building, between boards †	...	...	...
Paper, metallic surfaced (*see* air spaces)	...	...	...
Wood and woodwork:			
Various common woods (average)	1.09	...	0.92
Various common woods, $\frac{7}{8}$-inch thick, average	...	0.95	1.05
White-pine lap siding, waterproof paper, $\frac{7}{8}$-inch sheathing	...	2.00	0.50
Metal lath and stucco, waterproof paper, $\frac{7}{8}$-inch sheathing	...	1.21	0.82
White-pine lap siding and waterproof paper	...	1.18	0.85
Windows:			
Single-glass windows	...	0.88	1.13
Double-glass or windows and storm sash	...	2.22	0.45

* The values in column C are from various sources, such as the United States Bureau of Standards and the American Society of Heating and Ventilating Engineers Guide. The values in columns A and B are the reciprocals of those in the last column.

† The use of building papers is to prevent passage of air only.

TABLE 4

AVERAGE COMPOSITION OF SOME FEEDSTUFFS USED IN THE FEEDING OF POULTRY

FEEDSTUFF	MOISTURE	ASH	CRUDE PROTEIN	CARBOHYDRATES		FAT, OR OTHER EXTRACT
				Crude Fiber	Nitrogen-Free Extract	
Grains and seeds	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Barley	10.4	2.9	11.8	5.9	66.9	2.1
Barley (Pacific Coast States)	10.1	2.6	8.7	5.7	71.0	1.9
Beans, navy	13.4	3.6	22.7	5.8	53.0	1.5
Beans, pinto	9.1	4.5	22.7	4.5	58.0	1.2
Bread	33.8	1.5	7.9	.7	55.4	.7
Brewers' grains, dried	7.0	3.7	26.2	14.7	41.8	6.6
Broomcorn	11.6	3.1	10.5	8.3	63.0	3.5
Buckwheat	11.9	1.8	10.1	10.4	63.5	2.3
Buckwheat middlings	11.4	4.7	28.6	6.0	42.2	7.1
Coconut meal (old process)	9.3	6.1	20.5	11.1	44.7	8.3
Corn	11.9	1.3	9.3	2.1	71.2	4.2
Corn, Argentine	11.0	1.7	11.0	1.8	68.8	5.7
Corn bran	9.9	2.3	9.9	9.6	61.6	6.7
Corn meal	11.2	.9	8.8	1.1	75.5	2.5
Corn-gluten feed	9.7	6.1	25.9	7.2	48.5	2.6
Corn-gluten meal	8.9	1.5	43.0	2.6	42.1	1.9
Cottonseed meal (41-per cent protein)	7.5	5.8	41.8	11.4	27.1	6.4
Cowpeas	11.1	3.5	23.5	4.1	56.3	1.5
Distillers' grains (corn)	7.0	2.3	31.2	11.5	37.5	10.5
Durra	10.0	2.0	10.2	1.7	72.6	3.5
Feterita	10.2	1.6	13.2	1.8	70.2	3.0
Field peas	9.3	3.3	23.3	5.9	57.0	1.2
Flaxseed	10.3	4.4	22.3	7.1	23.1	32.8
Garden peas	11.8	3.0	25.6	4.4	53.6	1.6
Hempseed	7.6	5.9	22.9	18.6	18.4	26.6
Hempseed meal	7.3	7.8	31.7	23.9	25.3	4.0
Hominy (pearled)	11.8	.7	7.4	.6	77.6	1.9
Hominy feed	8.8	2.9	11.0	5.1	65.5	6.7
Kafir	11.7	1.6	11.5	2.0	70.1	3.1
Linseed meal (old process)	9.4	5.8	35.3	8.5	35.0	6.0
Mált sprouts	7.9	5.9	26.0	13.0	45.7	1.5
Millet (proso)	9.6	3.4	11.6	8.7	63.1	3.6
Milo	11.0	2.0	11.0	2.2	70.9	2.9
Oats	10.1	3.4	11.2	11.3	59.5	4.5
Oatmeal, or rolled oats	8.6	2.2	16.2	2.1	64.2	6.7
Peanuts (hulls on)	6.0	2.8	24.8	17.8	14.0	34.6
Peanut kernels	5.4	2.3	30.4	2.7	11.6	47.6
Peanut meal (no hulls) (old process)	6.9	5.6	45.7	9.2	24.0	8.6
Rice (whole)	10.3	4.7	7.9	8.8	66.3	2.0
Rice (polished)	11.8	.5	7.5	.4	79.4	.4
Rice bran	8.8	10.9	13.0	12.5	41.1	13.7
Rye	10.7	2.0	11.5	2.1	72.0	1.7
Soybeans	8.8	4.8	37.9	5.0	26.6	16.9
Soybean meal	9.1	5.6	43.9	5.9	30.0	5.5

[2] From U. S. D. A. Yearbook of Agriculture, 1939.

TABLE 4 (*Continued*)

FEEDSTUFF	MOISTURE	ASH	CRUDE PROTEIN	CARBOHYDRATES Crude Fiber	CARBOHYDRATES Nitrogen-Free Extract	FAT, OR OTHER EXTRACT
Grains and seeds	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Shallu	10.0	1.8	12.9	1.8	70.0	3.5
Sunflower seed	7.4	3.4	16.0	28.6	21.4	23.2
Sunflower seeds (hulled)	5.0	3.8	28.0	6.0	16.2	41.0
Velvetbeans	10.0	3.0	24.8	6.2	50.8	5.2
Wheat	11.0	1.8	12.4	2.4	70.5	1.9
Wheat bran	10.2	5.9	15.6	9.0	55.1	4.2
Wheat flour	12.9	.4	10.7	.4	74.2	1.4
Wheat-flour middlings	10.5	3.5	17.0	5.1	59.3	4.6
Wheat-germ meal	8.7	4.6	28.9	2.7	44.7	10.4
Wheat middlings, standard	11.1	4.1	16.9	6.6	56.6	4.7
Wheat red-dog flour	10.2	2.7	16.9	3.2	62.6	4.4
Wheat shorts (gray)	10.3	4.1	17.6	5.5	58.0	4.5
Feeds of animal origin						
Beef scrap	6.5	21.5	58.0	2.2	.7	11.1
Bonemeal, steamed	3.1	73.8	13.0	.8	2.8	6.5
Bonemeal, special steamed	3.1	85.1	6.5	2.6	2.1	.6
Buttermilk	90.8	.8	3.2	.0	4.6	.6
Buttermilk, condensed	71.6	3.5	10.6	.0	12.2	2.1
Buttermilk, dried	7.1	10.1	33.4	.4	44.0	5.0
Crab meal	8.1	40.1	34.7	8.5	6.5	2.1
Fish meal (average of unidentified fish meals)	8.0	19.7	60.4	.7	3.5	7.7
Fish meal, herring	9.1	12.1	66.0	.6	3.0	9.2
Fish meal, menhaden	8.0	20.4	57.5	.8	4.1	9.2
Fish meal, whitefish (high ash)	7.8	26.0	61.6	.4	1.2	3.0
Fish meal, whitefish (low ash)	12.1	17.6	60.9	.6	.1	8.7
Fish meal, sardine	8.0	15.0	67.0	.4	3.6	6.0
Fish meal, tuna	5.0	20.2	60.7	.4	5.1	8.6
Liver meal, Argentine	5.0	5.0	65.4	.8	9.8	14.0
Meat scrap (55-per cent protein)	6.7	24.2	55.2	2.2	1.0	10.7
Meat-and-bone scrap (50-per cent protein)	6.0	29.2	50.0	2.1	1.8	10.9
Pork liver, dried	4.8	5.3	63.7	.4	15.0	10.8
Pork cracklings	5.0	2.3	56.4	.0	4.1	32.2
Shrimp meal (or bran)	11.0	33.9	42.0	9.5	1.4	2.2
Skim milk	90.5	.7	3.5	.0	5.1	.2
Skim milk, dried	6.0	7.9	35.0	.0	50.0	1.1
Tankage (60-per cent protein)	8.0	19.5	59.8	2.7	1.8	8.2
Whey	93.7	.6	.8	.0	4.9	.0
Whey, dried	6.3	8.5	12.5	.3	71.7	.7
Green feeds, etc.						
Alfalfa, fresh	73.8	2.5	4.6	7.5	10.7	.9
Alfalfa-leaf meal	7.8	12.0	20.4	17.1	40.1	2.6
Alfalfa meal	8.3	8.7	16.0	27.3	37.2	2.5

TABLE 4 (*Continued*)

Feedstuff	Moisture	Ash	Crude Protein	Carbohydrates: Crude Fiber	Carbohydrates: Nitrogen-Free Extract	Fat, or Other Extract
Grains and seeds	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Beet pulp, dried	9.0	3.3	9.3	19.1	58.5	.8
Cabbage	90.8	.8	1.8	1.1	5.2	.3
Cane molasses	24.8	8.2	3.0	.0	64.0	.0
Carrots	88.4	1.1	1.1	1.2	7.9	.3
Grapefruit refuse, dried	9.3	4.3	4.8	11.6	68.7	1.3
Kale	88.4	1.9	2.4	1.5	5.3	.5
Mangels	90.1	1.1	1.5	.8	6.4	.1
Orange peel, dried	14.0	4.1	5.8	10.6	64 8	.7
Orange-pulp meal	10.8	3.4	7.5	8.9	67.9	1.5
Potatoes	78.8	.9	2.0	.5	17.7	.1
Rape	84.6	2.2	2.6	2.4	7.6	.6
Red clover hay	12.3	6.7	12.7	25.7	39.6	3.0
Rutabagas	88.8	1.0	1.2	1.5	7.3	.2
Turnips	90 6	.8	1.3	1.1	6.0	.2
Yeast, brewers', dried	7.0	7.3	46.5	1.1	35.3	2.8

TABLE 5

Average Calcium, Phosphorus, and Manganese Content of some Feedstuffs Used in the Feeding of Poultry [3]

Feedstuff	Calcium (Ca)	Phosphorus (P)	Manganese (Mn)
Grains and seeds	*Per cent*	*Per cent*	*Parts per million*
Barley	0.05	0.36	16
Beans, navy	.16	.45	13
Bread	.03	.10	4
Brewers' grains, dried	.20	.46	20
Buckwheat	.06	.43	80
Coconut meal (old process)	.29	.64	85
Corn	.01	.29	5
Corn bran	.03	.20	16
Corn-gluten feed	.13	.64	24
Corn-gluten meal	.06	.40	4
Corn meal	.01	.30	4
Cottonseed meal (41-per cent protein)	.23	1.18	18
Cowpeas	.10	.46	30
Distillers' grains (corn), dried	.04	.30	20
Feterita	.02	.32	(1)
Field peas	.08	.40	30
Flaxseed	.25	.66	35
Garden peas	.08	.40	30
Hempseed meal	.22	.87	(1)
Hominy	.01	.08	2
Hominy feed	.03	.51	16
Kafir	.03	.35	16
Linseed meal (old process)	.33	.74	40
Malt sprouts	.18	.70	35
Millet (proso)	.01	.33	35
Milo	.04	.32	15
Oats	.10	.36	34
Oatmeal, or rolled oats	.08	.44	20
Peanut kernels	.07	.39	(1)
Peanut meal (old process)	.18	.56	(1)
Rice (polished)	.01	.09	12
Rice bran	.10	1.84	280
Rye	.05	.36	40
Soybeans	.20	.53	31
Soybean meal	.29	.69	30
Sunflower seed	.41	.99	(1)
Wheat	.04	.39	39
Wheat bran	.11	1.21	119
Wheat flour	.02	.11	4
Wheat-flour middlings	.07	.69	113
Wheat-germ meal	.07	1.01	160
Wheat middlings, standard	.08	.93	119
Wheat red-dog flour	.07	.59	35
Wheat shorts	.08	.93	60
Feeds of animal origin			
Beef scrap	7.23	3.73	5
Buttermilk, liquid	.18	.10	Trace
Buttermilk, condensed	.56	.33	0.2
Buttermilk, dried	1.56	1.05	.4
Crab meal	13.25	.50	(1)
Feeds of animal origin—Continued	*Per cent*	*Per cent*	*Parts per million*
Fish meal (average of unidentified fish meals)	6.50	3.60	45
Fish meal, herring	3.83	2.50	(1)
Fish meal, whitefish (high ash)	9.09	4.70	(1)
Fish meal, whitefish (low ash)	5.84	3.04	(1)
Fish meal, sardine	4.73	2.63	40
Fish meal, tuna	6.25	3.46	(1)
Liver meal, Argentine	.11	.90	4
Meat-and-bone scrap (50-per cent protein)	10.20	4.91	10
Meat scrap (55-per cent protein)	8.25	4.00	18
Pork liver, dried	.06	1.12	4
Skim milk, liquid	.13	.11	Trace
Skim milk, dried	1.27	.96	0.6
Tankage (60-per cent protein)	7.16	3.53	14
Whey, liquid	.05	.04	1
Whey, dried	.83	.70	14
Green feeds, etc.			
Alfalfa (green)	.42	.07	7
Alfalfa-leaf meal	1.90	.22	30
Alfalfa meal	1.44	.21	26
Beet pulp, dried	.70	.07	23
Cabbage	.07	.04	21
Cane molasses	.56	.06	(1)
Carrots	.06	.07	(1)
Grapefruit refuse, dried	.74	.10	(1)
Kale	.18	.07	(1)
Orange peel, dried	.73	.11	(1)
Orange-pulp meal	.64	.10	(1)
Potatoes	.02	.06	3
Rape	.34	.07	50
Red clover hay	1.17	.18	40
Rutabagas	.06	.04	(1)
Turnips	.05	.05	(1)
Yeast, dried	1.26	1.21	2
Calcium, phosphorus, and manganese supplements			
Bone, fresh	22.95	10.42	12
Bonemeal	27.00	13.00	13
Bonemeal, steamed	28.80	13.34	5
Bonemeal, special steamed	31.30	14.49	2
Crab shell	23.74	2.55	300
Gypsum	25.00	Trace	(1)
Limestone, high-calcium	39.20	.00	200
Oystershell, washed	38.00	Trace	100
Manganous sulfate, anhydrous	.00	.00	*Per cent* 36.3
Manganous sulfate, tetrahydrate	.00	.00	24.6

[1] Information lacking.

[3] From U. S. D. A. Yearbook of Agriculture, 1939.

TABLE 6

Average Vitamin Content of Some Feedstuffs Used in the Feeding of Poultry[4]

Feedstuff	Vitamin A per Pound	Vitamin B_1 per Pound	Vitamin D per Pound[1]	Vitamin E[2]	Vitamin G (Riboflavin) per Pound	Chick Antidermatosis Factor per Pound
Grain and seeds	*International Units*	*International Units*	*A.O.A.C. chick units*[3]		*Micrograms (gammas)*[4]	*Modified Jukes-Lepkovsky units*[5]
Barley	400	250	Trace	++	400	0.7
Beans, navy	([6])	250	....	([6])	([6])	.1
Beans, pinto	([6])	2,270	....	([6])	([6])	([6])
Bread	50	10	....	([6])	([6])	([6])
Buckwheat	([6])	500	....	([6])	300	([6])
Corn, yellow	3,180	270	....	++	450	.7
Corn, white	0	270	....	++	450	.7
Corn-gluten meal (yellow)	6,800	([6])	....	0	0	([6])
Cottonseed meal (41-per cent protein)	600	1,800	....	([6])	300	1.0
Cowpeas	1,360	450	....	([6])	350	1.3
Field peas	2,720	450	....	([6])	([6])	([6])
Garden peas	4,540	450	....	++	([6])	1.5
Hempseed meal	([6])	([6])	....	++	1,100	1.0
Kafir	250	([6])	....	([6])	([6])	([6])
Linseed meal (old process)	200	2,000	....	+	900	0.1
Milo	250	([6])	....	([6])	400	.7
Oats	80	270	....	++	400	.7
Oatmeal, or rolled oats	([6])	230	....	++	([6])	.8
Peanuts (hulls on)	([6])	900	....	++	950	3.5
Peanut kernels	([6])	1,500	....	++	1,200	4.0
Peanut meal, no hulls (old process)	250	900	....	++	1,200	4.0
Rice bran	([6])	1,500	....	([6])	900	1.8
Rye	([6])	250	....	++	([6])	([6])
Soybeans	600	1,100	....	([6])	1,300	1.0
Soybean meal	170	900	Trace	([6])	1,400	1.0
Wheat	140	340	....	++	400	.7
Wheat bran	150	450	....	++	1,000	1.8
Wheat flour	([6])	10	....	([6])	([6])	([6])
Wheat-germ meal	1,900	1,930	....	++++	1,800	.5
Wheat-flour middlings	100	800	....	++	700	.7
Wheat middlings, standard	120	1,000	....	+++	900	.8
Wheat red-dog flour	60	([6])	....	([6])	450	([6])
Wheat shorts	120	1,000	....	+++	900	.8
Feeds of animal origin						
Buttermilk, liquid	25	40	([6])	([6])	1,200	.3
Buttermilk, dried	200	400	Trace	+	9,000	3.0
Buttermilk, sweet cream, dried	200	400	Trace	+	14,000	3.0

[1] Leaders (..........) mean that the feedstuff contains no appreciable quantity of vitamin D.

[2] The symbols in this column have the following meanings: + Fair source of vitamin E; ++ Good source of vitamin E; +++ Very good source of vitamin E; ++++ Excellent source of vitamin E.

[3] This is the official unit of the Association of Official Agricultural Chemists. It is equivalent to 1 International Unit of the kind of vitamin D found in pure cod-liver oil.

[4] A microgram, or gamma, is one-millionth of a gram; it is equal to approximately one twenty-eight millionth of an ounce.

[5] The modification consists in giving the same value to a pound of the feedstuff as was originally given to a gram. In order that a diet may supply enough of the chick antidermatosis factor, it should contain not less than 0.9 modified Jukes-Lepkovsky unit per pound.

[6] Information on vitamin content is lacking.

TABLE 6 (*Continued*)

Feedstuff	Vitamin A per Pound	Vitamin B1 per Pound	Vitamin D per Pound [1]	Vitamin E [2]	Vitamin G (Riboflavin) per Pound	Chick Antidermatosis Factor per Pound
	International Units	*International Units*	*A.O.A.C. chick units* [3]		*Micrograms (gammas)* [4]	*Modified Jukes-Lepkovsky units* [5]
Grain and seeds						
Cod-liver oil	340,190 [7]	0	45,360 [7]	0	0	0
Cod-liver oil, fortified	1,362,000	0	181,600	([6])	0	0
Fish meal, white	([6])	([6])	([6])	([6])	4,500	2
Fish meal, sardine	([6])	([6])	([6])	([6])	3,200	2
Fish meal, menhaden	([6])	([6])	([6])	([6])	2,250	.2
Liver meal, Argentine	([6])	([6])	([6])	([6])	18,500	8.0
Meat scrap	([6])	([6])	... ..	([6])	2,700	.2
Pork liver, dried	47,670	170	200	([6])	45,360	100
Sardine (pilchard) oil	45,240	([6])	45,360	([6])	0	0
Skim milk, liquid	15	40	....	+	1,00	.3
Skim milk, dried	130	400	....	+	9,500	2.5
Tankage	([6])	([6])	....	([6])	800	([6])
Whey, dried	([6])	([6])	....	([6])	12,000	4 0
Green feeds, etc.						
Alfalfa (green)	63,560	225	.. .	++	2,000	.1
Alfalfa-leaf meal, dehydrated	95,000	450	.....	+++	8,000	3.0
Alfalfa-leaf meal	32,000	400	14	+++	7,000	2 0
Alfalfa meal	13,000	400	....	+++	5,000	1.5
Cabbage	200	100	....	([6])	100	([6])
Cane molasses	([6])	([6])	....	([6])	2,000	6 0
Carrots	18,200	100	....	([6])	120	1
Kale	181,400	100	....	([6])	2,240	([6])
Potatoes	220	80	. ....	([6])	55	([6])
Red clover hay	9,000	450	.. .	+++	([6])	([6])
Turnips	([6])	70	.. ....	([6])	45	([6])
Yeast, brewers', dried	([6])	4,500	....	0	16,000	15.0

[7] Cod-liver oil, if it is to be sold legally as such in interstate commerce, must contain at least 272,150 International Units of vitamin A and 38,590 International Units of vitamin D per pound. The vitamin A content of cod-liver oil varies from 272,150 to about 1,000,000 International Units per pound and the vitamin D content from 38,590 to about 160,000 units per pound. Cod-liver oil and other vitamin-bearing fish oils should be purchased only from reliable sources and should be used according to the manufacturer's guarantee of their vitamin potency.

[4] From U. S. D. A. Yearbook of Agriculture, 1939

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